

Quantifying Fishing Activity Within and Adjacent to NE Gulf of Mexico Marine Protected Areas

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Technical Report
Project Phase 1
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1.0 Introduction

1.1 Background and Rationale

In July 1999, the National Marine Fisheries Service officially established two areas closed to most fishing in the northeastern Gulf of Mexico to evaluate the utility of closed areas in the protection of spawning aggregations of gag grouper. The area closures went into effect on June 19, 2000, for a four year period, and were extended for an additional 6 years at the July 2003 meeting of the Gulf of Mexico Fishery Management Council. A key factor to the success of marine protected areas (MPAs) and one often assumed in the determination of their effects is zero fishing mortality within the closed areas. A study was initiated in 2004 to develop and implement aerial surveys to quantify the amount of fishing activity within and adjacent to the Madison-Swanson and Steamboat Lumps reserves. The study was designed to provide data that will assist in the analysis of MPA performance and also for gaining compliance by fishers.

1.2 Project Goal and Objectives

The goal of this project was to determine the amount, type, and spatial pattern of fishing activity within the Madison-Swanson and Steamboat Lumps MPAs as well as within adjacent areas open to fishing on the west Florida shelf. The study had three main objectives: 1) to develop field sampling methods using fixed-wing aircraft for obtaining georeferenced data on fishing and other vessels operating within the Madison-Swanson and Steamboat Lumps MPAs and adjacent areas; 2) to develop a statistical sampling design and conduct seasonal aerial surveys of vessels in the target MPAs and adjacent areas; and 3) to develop statistical analysis procedures for quantifying fishing and other vessel activity within the survey domain.

The study was designed to be conducted in two phases over a two-year period. Phase 1 (year 1) primarily focused on objectives 1 and 2. Aerial surveys were completed for two seasons in 2005, out of four seasons planned for the project. Two additional seasonal surveys were intended to be completed in Phase 2 (year 2), as well as project objective 3, during the time frame from August 2005 to September 2006. However, funding limitations precluded carrying out the aerial surveys of Phase 2. Some additional funding was provided in September 2006 to complete project objective 3 using data from the two seasonal surveys of 2005; this work is scheduled for completion in September 2007. This report primarily focuses on Phase 1 of the project, along with some preliminary results.

1.3 Project Management

The study was a collaborative effort between the University of Miami's Rosenstiel School of Marine and Atmospheric Science (UM-RSMAS), NOAA Fisheries, and the NOAA flight group based in Tampa, Florida. The University of Miami component was carried out through the Cooperative Institute for Marine and Atmospheric Studies (CIMAS) under CIMAS Research Theme 4: Human Interactions with the Environment.

2.0 Development of Sampling Design and Methodology

To facilitate delineation of the survey domain and development of sampling methods, the deep reef fishing fleet and target species were characterized for the west Florida shelf region. Fishing activity for this fleet is concentrated on the 'shelf break' area in water depths ranging from 55 to 140 m. Steamboat Lumps MPA is located in statistical fishing area 6, and Madison-Swanson MPA is in area 8 (**Figure 1**). The shelf break area is located about 100 nautical miles (nm) west of Tampa, Florida, where NOAA flight operations are based. NOAA Fisheries provided a summary analysis of fishery-dependent catch-effort data for the west Florida shelf. Peak catches of reef species occurred in statistical areas 5 and 6. Target reef species included two snappers, red and vermilion, and three groupers, red, scamp, and gag. NOAA Fisheries scientists also provided information on the principal vessel-gear types likely to be fishing for reef species in this region: commercial workboats 30-50 ft in length outfitted with either 'bandit rig' hook-line gear or demersal longline gear; and, fiberglass recreational/charter vessels >30 ft in length deploying hook-line gear.

An in-flight data recording system was adapted from Ault et al. (2005) to collect real-time information on vessels. The main components of the system were a laptop computer interfaced with a global positioning (GPS) unit and GIS software. During a flight, the GIS system displayed the real-time position of the aircraft on a digital nautical chart. A scientific observer recorded the latitude-longitude position of vessels on this visual display via a mouse click. A dialog box was activated at each mouse click, enabling the observer to quickly record the type of vessel (e.g., commercial longline, recreational/charter) and its disposition (e.g., fishing, cruising). Data records were automatically written to a digital file as they were entered during a flight. This in-flight recording system was augmented with a digital camera (Nikon D2H digital SLR camera, with a vibration reduction 70-200 mm zoom lens) and a second GPS

unit. Time synchronization between the camera and GPS unit enabled the latitude-longitude position to be determined for photos of vessels. Several photos were taken of each encountered vessel: (i) 1-2 oblique photos for discerning vessel type and disposition; and (ii) a close to overhead photo to obtain the precise latitude-longitude position. The photographs were used to confirm/refine the in-flight data recorded on the laptop GIS system.

Several test flights were conducted in December 2004 using a small, twin-engine aircraft (Shrike Aero Commander) to finalize the onboard data recording equipment and protocols, survey domain, flight tracks, etc. Data recording procedures are summarized in the ‘checklist’ shown in **Figure 2**. The survey domain was delineated as a 20 x 160 nm area encompassing the shelf-break deep-reef habitat in statistical areas 5, 6, and 8, which also includes the Madison-Swanson and Steamboat Lumps MPAs (**Figure 1**). The domain was divided into two 10 nm-wide flight tracks, east and west. Observers were able to readily spot vessels within 5 nm on either side of the aircraft when flying at an altitude of approximately 1000 ft. The statistical sample unit was comprised of one complete coverage of the domain (both flight tracks), which could be accomplished in one day. From 5 to 6 h of flight time was required to complete both tracks; a refueling stop in Panama City, FL, was often required in between the two flight tracks. Flights were conducted between 0900 h and 1600 h on a given day. Protocols were also developed for obtaining oceanographic-meteorological data in conjunction with aerial surveys for use as covariates in statistical model development (**Appendix A**).

A time-stratified random sampling design was developed for aerial surveys of vessels. Time strata for allocation of flight days were based on several variables that could potentially influence fishing activity within the sampling domain: (i) spawning seasons of target species; (ii) commercial and recreational open/closed fishing seasons for red snapper and groupers; and, (iii) midweek and weekend/holiday time periods. Seasonal closure regulations for reef fishes in the west Florida shelf region pertain to 4 species: red snapper, black grouper, red grouper, and gag. For red snapper, the recreational fishery is open from April 15 to October 31 and closed otherwise. The commercial fishery for red snapper is open for the first 10 days of the month from February to December, with potential additional restrictions based on seasonal and annual catch quotas. The commercial fishery for black grouper, red grouper, and gag is closed from February 15 to March 15, and there is no seasonal closure for the recreational fishery for these species. Specific flight days were randomly selected within each time strata, with the constraint

of a maximum of one flight within a consecutive 5-day midweek period or 2-day weekend period for a given time strata. This constraint was imposed to attempt to sample across the widest range of weather conditions as possible. The order of sampling east-west flight tracks was also randomized for each flight day.

3.0 Phase 1 Results

Twenty-four flight surveys (daily flights) were conducted during January-April 2005 (**Table 2**), and twenty-five flight surveys were conducted during May-September 2005 (**Table 3**). Sample sizes by time strata are given in **Table 4**. Photos showing the range of vessel types observed during the flight surveys are provided in **Figure 3**. Daily flight maps showing the location of vessel types for Jan-Apr and May-Sep time periods are given in **Appendices B1** and **B2**, respectively. The relative composition of vessel types by time strata for the Jan-Apr and May-Sep time periods is provided in **Figures 4** and **5**, respectively. Commercial fishing vessels were the principal vessel type observed irrespective of day of the week category or fishing season in each time period.

Summaries of numbers of vessels by type and disposition category are given in **Table 5a** for Jan-Apr and in **Table 5b** for May-Sep. Summary maps of vessel location and disposition for Jan-Apr are shown in **Figure 6** for commercial fishing vessels and **Figure 7** for recreational fishing vessels. A summary map of locations of non-fishing vessel types for Jan-Apr is shown in **Figure 8**. Summary maps of vessel location and disposition for May-Sep are shown in **Figure 9** for commercial fishing vessels and **Figure 10** for recreational fishing vessels. A summary map of locations of non-fishing vessel types for May-Sep is shown in **Figure 11**. During Jan-Sep, 1.9% of commercial vessels engaged in fishing activities were observed inside MPAs, whereas 5.3% of recreational vessels engaged in fishing activities were observed in MPAs (**Table 6a**). These percentages were 1.7% for commercial vessels and 3.1% for recreational vessels during May-Sep (**Table 6b**).

4.0 Next Research Steps

The next phase of the study, scheduled to conclude in fall 2007, is focusing on development and application of statistical analysis methods to quantify fishing activity in open and protected areas within the survey domain. Both survey design (Cochran 1977, Ault et al.

1999) and model-based analysis techniques (McCullagh and Nelder 1989; Greene 1993; Neter et al. 1996; Agresti 2002) are being explored.

5.0 Acknowledgments

We thank all the NOAA pilots based at MacDill AFB, Tampa, Florida, who participated in the study. We also thank Miles Croom who served as the NOAA Fisheries program manager for the project.

6.0 Literature Cited

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7.0 Tables and Figures

Table 1. Time strata variables for the west Florida shelf aerial survey.

Time Strata Variable	Code	Description
Day of Week	MW	Midweek
	WH	Weekend/holiday
Fishing Season	GR	Groupers open (black, red, gag), snapper closed (red)
	SN	Snapper open, groupers closed
	OP	Both open
	CL	Both closed

Table 2. Date and fishing time strata characteristics for aerial surveys during January to April, 2005. Day of week and fishing season codes are given in Table 1.

Year	Month	Day	Day of Week	Commercial Fishing Season	Recreational Fishing Season
2005	1	4	MW	GR	GR
2005	1	12	MW	GR	GR
2005	1	16	WH	GR	GR
2005	2	5	WH	OP	GR
2005	2	8	MW	OP	GR
2005	2	9	MW	OP	GR
2005	2	12	WH	GR	GR
2005	2	16	MW	CL	GR
2005	2	19	WH	CL	GR
2005	2	28	MW	CL	GR
2005	3	3	MW	SN	GR
2005	3	5	WH	SN	GR
2005	3	9	MW	SN	GR
2005	3	10	MW	SN	GR
2005	3	12	WH	CL	GR
2005	3	13	WH	CL	GR
2005	3	14	MW	CL	GR
2005	3	20	WH	GR	GR
2005	3	21	MW	GR	GR
2005	4	3	WH	OP	GR
2005	4	5	MW	OP	GR
2005	4	9	WH	OP	GR
2005	4	14	MW	GR	GR
2005	4	15	MW	GR	GR

Table 3. Date and fishing time strata characteristics for aerial surveys during May to September, 2005. Day of week and fishing season codes are given in Table 1.

Year	Month	Day	Day of Week	Commercial Fishing Season	Recreational Fishing Season
2005	5	6	MW	OP	OP
2005	5	17	MW	GR	OP
2005	5	22	WH	GR	OP
2005	5	26	MW	GR	OP
2005	6	3	MW	OP	OP
2005	6	5	WH	OP	OP
2005	6	7	MW	OP	OP
2005	6	12	WH	GR	OP
2005	6	15	MW	GR	OP
2005	6	18	MW	GR	OP
2005	6	26	WH	GR	OP
2005	6	30	MW	GR	OP
2005	7	1	MW	OP	OP
2005	7	2	WH	OP	OP
2005	7	5	MW	OP	OP
2005	7	12	WH	GR	OP
2005	7	16	MW	GR	OP
2005	7	21	MW	GR	OP
2005	7	24	WH	GR	OP
2005	7	28	MW	GR	OP
2005	8	2	MW	OP	OP
2005	8	9	MW	OP	OP
2005	8	25	MW	GR	OP
2005	9	1	MW	OP	OP
2005	9	3	WH	OP	OP

Table 4. Aerial survey sample sizes (number of daily flights) by time strata.

Survey Season	Recreational Fishing Season	Commercial Fishing Season	Midweek n	Weekend/Holiday n	Total n
Jan-Apr	GR	GR	5	3	8
	GR	SN	3	1	4
	GR	OP	3	3	6
	GR	CL	3	3	6
May-Sep	OP	GR	9	5	14
	OP	OP	8	3	11

Table 5. Number of vessels in survey domain spatial zones by type and disposition for **(a)** Jan-Apr 2005 and **(b)** May-Sep 2005.

(a) Jan-Apr 2005 (survey n=24)

Spatial Zone	Commercial		Recreational		Non-Fishing Vessels		
	Fishing	Cruising	Fishing	Cruising	Freighter	Sailboat	¹ Other
Open	256	79	36	16	46	6	3
Madison-Swanson MPA	2	1	2	0	1	0	2
Steamboat Lumps MPA	3	0	0	0	2	0	2
Total	261	80	38	16	49	6	7

(b) May-Sep 2005 (survey n=25)

Spatial Zone	Commercial		Recreational		Non-Fishing Vessels		
	Fishing	Cruising	Fishing	Cruising	Freighter	Sailboat	¹ Other
Open	230	77	123	59	25	4	5
Madison-Swanson MPA	3	3	4	1	1	0	1
Steamboat Lumps MPA	1	0	0	0	0	0	0
Total	234	80	127	60	26	4	6

¹Includes Research and Coast Guard Vessels

Table 6. Vessels fishing in MPAs for (a) Jan-Apr 2005 and (b) May-Sep 2005.

(a) Jan-Apr 2005

Vessel Type	Total Vessels Fishing	Vessels Fishing in MPAs	
		Number	Percentage
Commercial	261	5	1.9%
Recreational	38	2	5.3%

(b) May-Sep 2005

Vessel Type	Total Vessels Fishing	Vessels Fishing in MPAs	
		Number	Percentage
Commercial	234	4	1.7%
Recreational	127	4	3.1%

Figure 2: Summary checklist of data recording procedures for aerial surveys.

BEFORE FLIGHT

Onboard Equipment Checklist

- ___ Laptop Computer & Data Supplies
 - Lap Desk
 - FlyDell computer
 - Trackball mouse
 - a/c cable
 - (3) blank CD-R w/case
 - Survey log sheet
- ___ Onboard GPS serial port cable (RS232)
- ___ Handheld GPS
 - Garmin 276C unit
 - Carrying case
 - a/c cable
 - USB cable
 - External antenna
- ___ Camera
 - Carrying case
 - Nikon D2H body
 - 70-200 mm lens
 - a/c cable
 - USB cable
 - Lens cleaning kit
 - Extra flash memory card & case
 - Manual

Survey logsheet.....record survey ID and track order (E,W) from schedule
 Create survey subfolder.....format <WFLyyyyymmdd>
 Create pix sub-subfolders.....format <pix_E> and <pix_W>
 Check camera battery level.....recharge if below 80%
 Clear camera flash memory.....transfer pix to hard drive & delete from memory

AFTER TAKEOFF, ENROUTE TO FLIGHT TRACK

Survey logsheet.....record date, names, flight start time
 A/C power.....on
 a/c cables for computer, handheld GPS, camera.....connect
 Handheld GPS.....on
 Computer.....startup
 GIS WFLaerial arcview project.....open
 Onboard GPS serial port cable.....connect to laptop
 Real-time flight track on GIS chart.....confirm
 Camera USB cable.....connect camera to laptop
 Camera.....on
 Camera clock.....synchronize w/ handheld GPS clock
 Nikon Capture software.....open, set folder (e.g., pix_E), set file prefix (wfl), set file suffix (E or W), set file number sequence start to 1

IN FLIGHT, APPROX. 5 MIN. BEFORE REACHING FLIGHT TRACK

Handheld GPS.....clear tracklog

VESSEL SURVEY PROTOCOL

Survey logsheet.....record survey start time
 Proceed along flight track, scan for vessels
 When a vessel is sighted:
 Approach vessel, adjust altitude as necessary.
 Take 1 or 2 photos, oblique view
 Take 1 photo, close to overhead view
 Record vessel info using GIS dialog
 Return to flight track at 90° angle, proceed along track

AFTER COMPLETING FLIGHT TRACK

Survey logsheet.....record survey end time, weather obs.
 GIS project.....close and save
 Nikon Capture.....close
 Camera.....off and disconnect USB
 Handheld GPS USB cable.....connect GPS to laptop
 Mapsource software.....open, transfer tracklog from Handheld GPS to computer, export tracklog file to tab delimited textfile (e.g., <track_yyyymmdd_E.txt>)
 Handheld GPS.....off and disconnect USB
 WFL main folder.....move file 'vesselxyinfo.txt' to survey subfolder
 Survey subfolder.....rename 'vesselxyinfo.txt' (to either 'vesselxyinfo_yyyymmdd_W.txt' or 'vesselxyinfo_yyyymmdd_E.txt')
 Onboard GPS serial port cable.....disconnect from laptop

After completing second flight track only:

Blank CD-R.....place in drive, copy & burn survey subfolder

Laptop.....shutdown

AFTER LANDING

Survey logsheet.....record flight end time, block time

Caution!

If the laptop needs to be shutdown during the survey due to problems with software, etc., make sure to disconnect the serial cable for the onboard GPS BEFORE rebooting. Following the sequence—1)reboot, 2)open ArcView project, 3) connect serial cable for onboard GPS—is essential. If the serial cable is connected before opening the ArcView project, the onboard GPS will take over control of the mouse/cursor.

Figure 3. (A) Two recreational vessels fishing. (B) Head boat fishing. (C) Sailboat cruising. (D) Freighter cruising. (E) Commercial vessel fishing (trawler). (F) Commercial bandit fishing. (G) Sea Tow fishing. (H) Commercial vessel fishing. (I) Commercial Longliner fishing. (J) US Coast Guard cruising. (K) NOAA vessel conducting research.



Figure 3 (cont.)



Figure 3 (cont.)



Figure 4. Relative composition of vessels types for surveys during January-April 2005 by day of week category for the following fishing seasons (see Table 1): **(a)** com=CL, rec=GR; **(b)** com=GR, rec=GR; **(c)** com=OP, rec=GR; **(d)** com=SN, rec=GR.

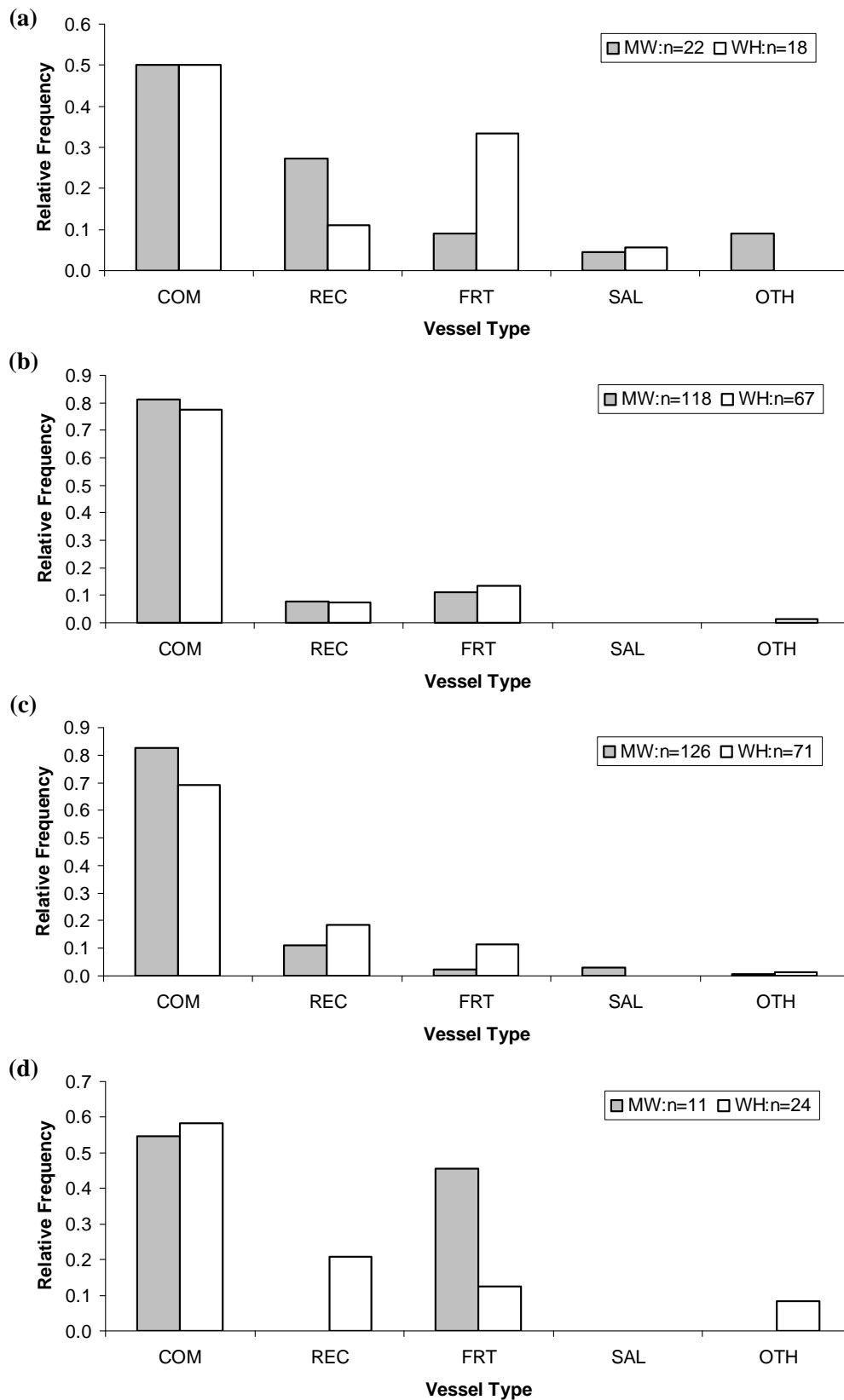


Figure 5. Relative composition of vessels types for surveys during May-September 2005 by day of week category for the following fishing seasons (see Table 1): **(a)** com=GR, rec=OP; **(b)** com=OP, rec=OP.

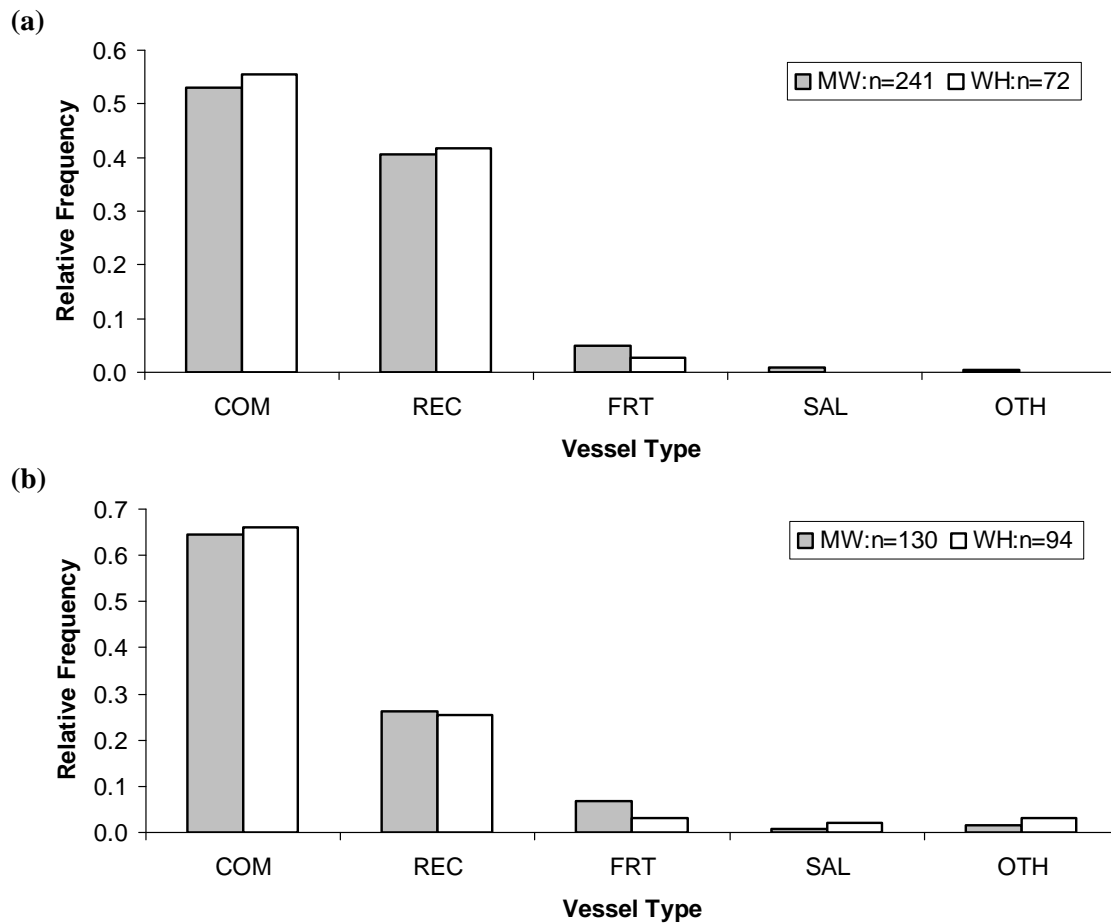


Figure 6. Summary map of location and disposition of commercial fishing vessels for January-April 2005 flight surveys.

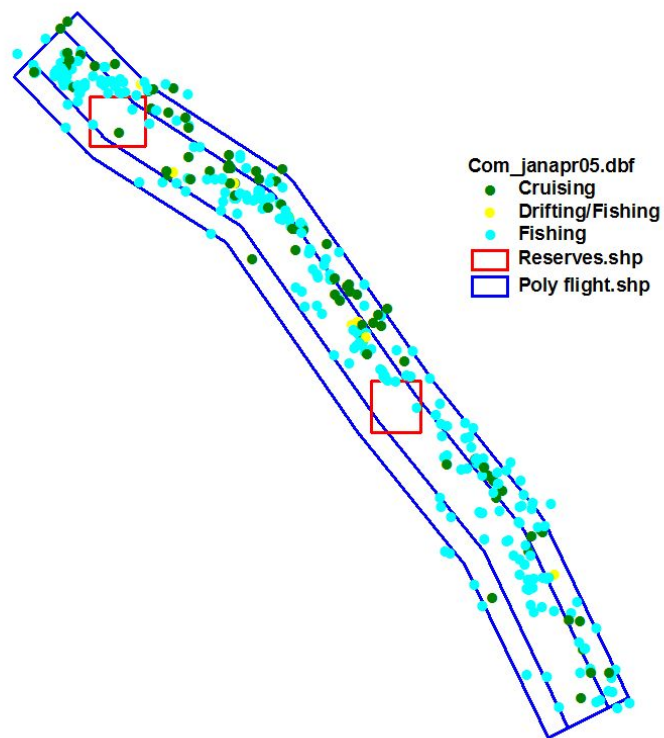


Figure 7. Summary map of location and disposition of recreational fishing vessels for January-April 2005 flight surveys.

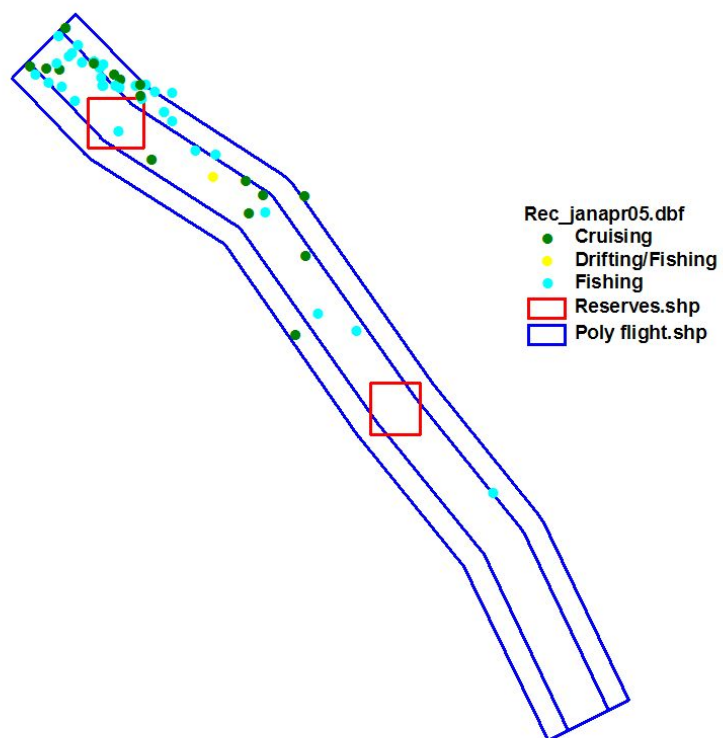


Figure 8. Summary map of location of non-fishing vessel types for January-April 2005 flight surveys.

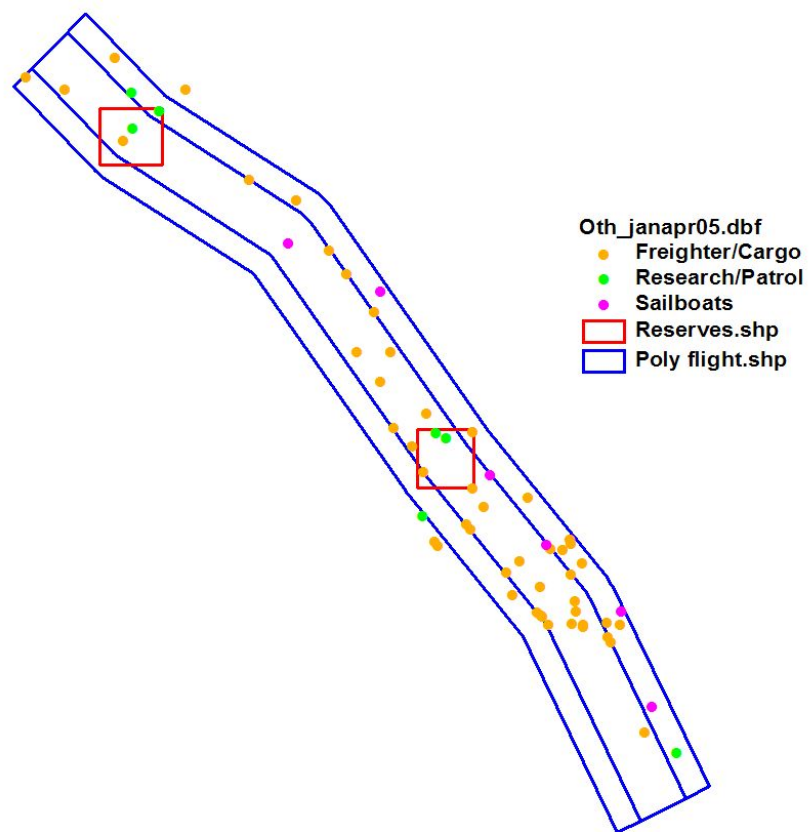


Figure 9. Summary map of location and disposition of commercial fishing vessels for May-September 2005 flight surveys.

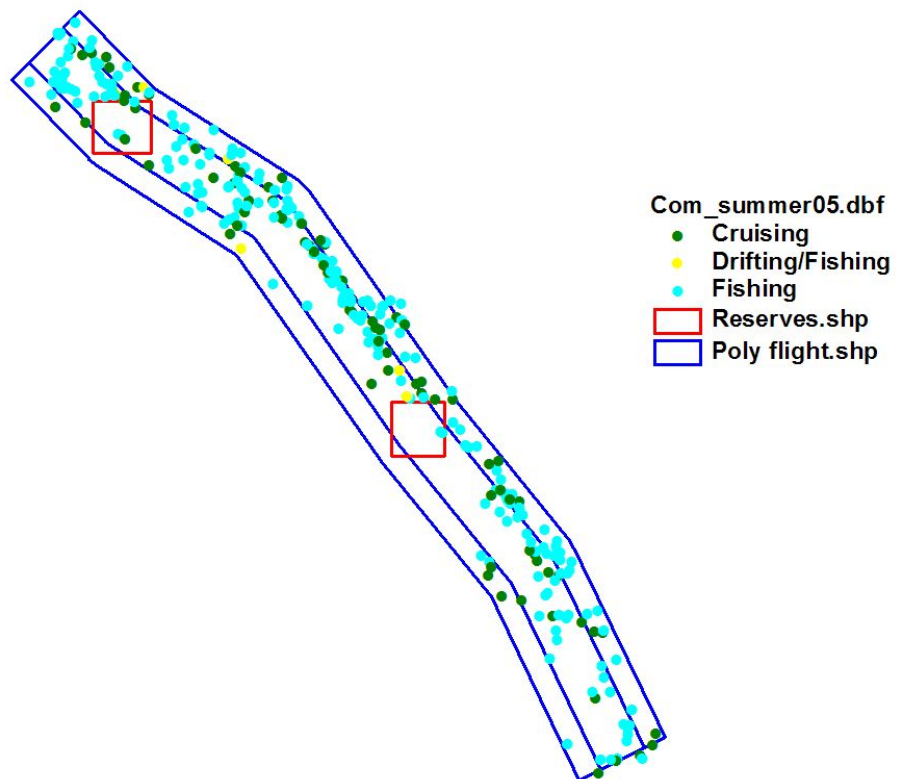
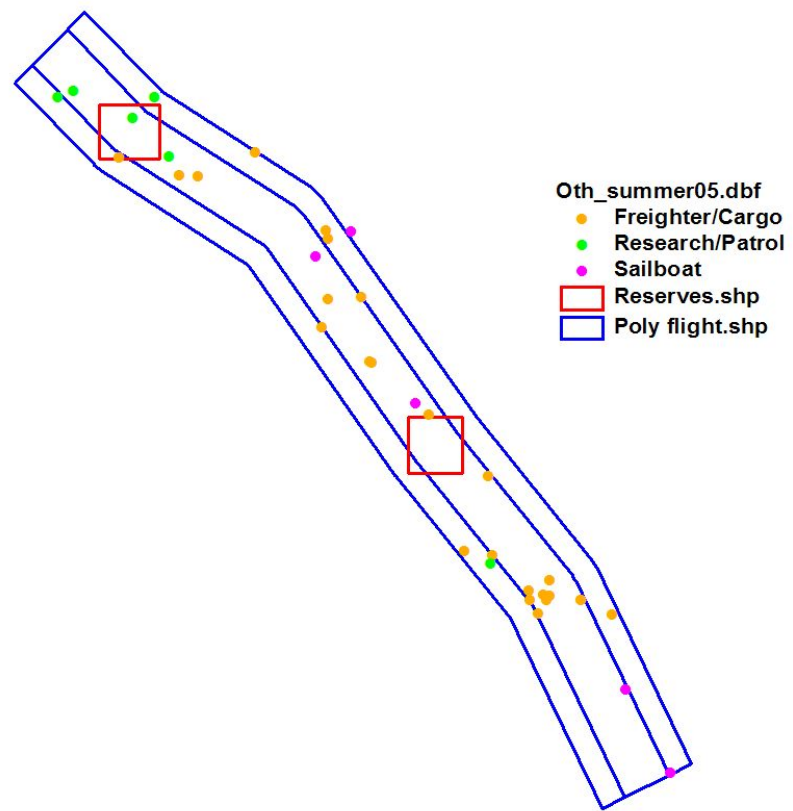


Figure 10. Summary map of location and disposition of recreational fishing vessels for May-September 2005 flight surveys.



Figure 11. Summary map of location of non-fishing vessel types for May-September 2005 flight surveys.



Appendix A: Oceanographic-Meteorological Data Procedures

There are three main types of weather data:

1. NWS Marine Forecasts
2. NOAA Oceanographic-Meteorological Buoys
3. Gulf of Mexico Satellite Images

NWS Marine Forecasts

1. Forecasts are stored as ascii (.txt) files in folder 'WFLshelf_aerial\forecasts'.
2. Forecasts are obtained from the NOAA National Data Buoy Center website:
www.ndbc.noaa.gov
3. On the website map, click on eastern Gulf of Mexico sector. This will bring up the names/locations of data buoys in the region.
4. Forecasts are obtained from the following 3 buoys:

Buoy Name	Forecast Link	Sector	Filename
42013	'Latest NWS Marine Forecast'	coast, Tampa to Big Bend	nws_yyyymmdd_1a
SGOF1	'Latest NWS Marine Forecast'	coast , BB to Panama City	nws_yyyymmdd_1b
42036	'Latest NWS Marine Forecast 2'	offshore, Gulf of Mexico	nws_yyyymmdd_2

5. Files are created by: (a) clicking on forecast link, (b) highlighting forecast text, (c) 'copy', (d) open Notepad, (e) 'paste', (f) 'Save as' filename in forecasts folder.
6. Optimal time for obtaining forecasts: afternoon (1630-1730) 2 days prior to survey date. Next best option: daytime, day before survey. Last resort: morning of survey.

NOAA Oceanographic-Meteorological Buoys

1. Buoy data are stored as ascii files in folder 'WFLshelf_aerial\databuoys'.
2. Buoy data are obtained from the NOAA National Data Buoy Center website, Gulf of Mexico sector, as described above.
3. Data are obtained from the following 4 buoys:

Buoy Name	Type	Location	Links	Filename
42013	COMPS	SE of domain, near coast	'Real Time Data', last 45 days; 'real time standard meteor. data'	WFL###_42013
SGOF1	C-MAN	N of domain, near coast	same	WFL###_SGOF1
42036	Moored	in/near domain	same	WFL###_42036
42039	Moored	W of domain, offshore	same	WFL###_42039

4. Files are created using Notepad as described above; ### is the 3-digit survey ID# from the

flight schedule; there is one file per buoy per flight survey.

5. First copy-paste labels, then copy-paste data records for: 0600 Eastern Time 2 days prior to survey through 1800 Eastern Time on day of survey. Buoy data are given in UTC (i.e., GMT) time units; EST is UTC -5 and EDT is UTC -4; so, for example, 0600 EST is 1100 UTC and 1800 EST is 2300 UTC. Buoy observations are taken hourly, not necessarily exactly at the top of each hour. Select the times closest to 0600 and 1800 Eastern Time for a given buoy. It is best to obtain buoy data approx. 7-10 days after a flight survey has been completed.

Gulf of Mexico Satellite Images

1. Images are stored as .gif files in folder 'WFLshelf_aerial\weatherloops\loop_yyyymmdd'.

2. Images are obtained from the NOAA GOES website, archive search page:

www.goes.noaa.gov/src/est.html

3. 2 sets of images are obtained for each survey: (1) 6 image set for 1215 to 1715 Eastern Time (e.g., 1715 to 2215 UTC for EST), day before survey; (2) 6 image set for 1015 to 1515 Eastern Time (e.g., 1515 to 2015 UTC for EST), day of survey. Two 'loop_yyyymmdd' folders as described above will thus be created for each survey.

4. Image selection specifications:

Sector: GOES East Hurricane

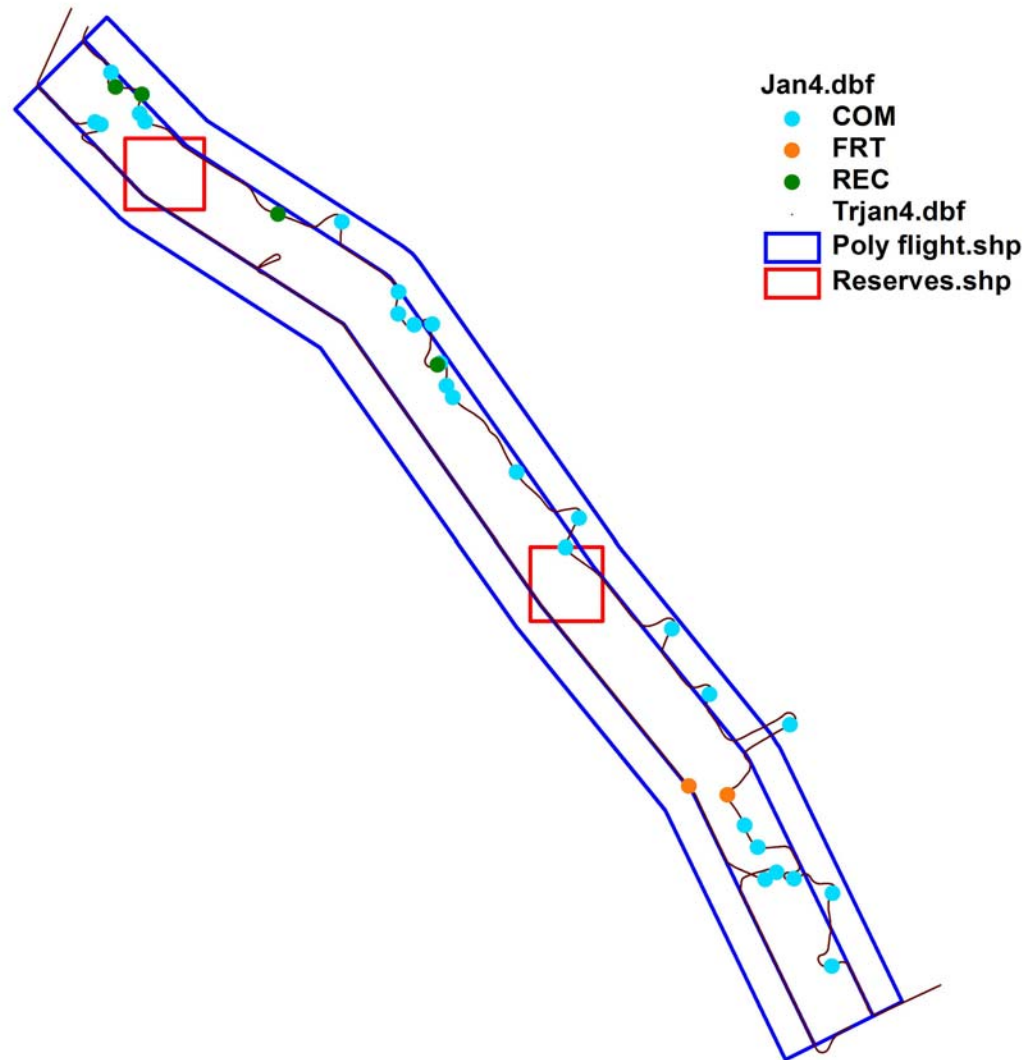
Channel: Water Vapor

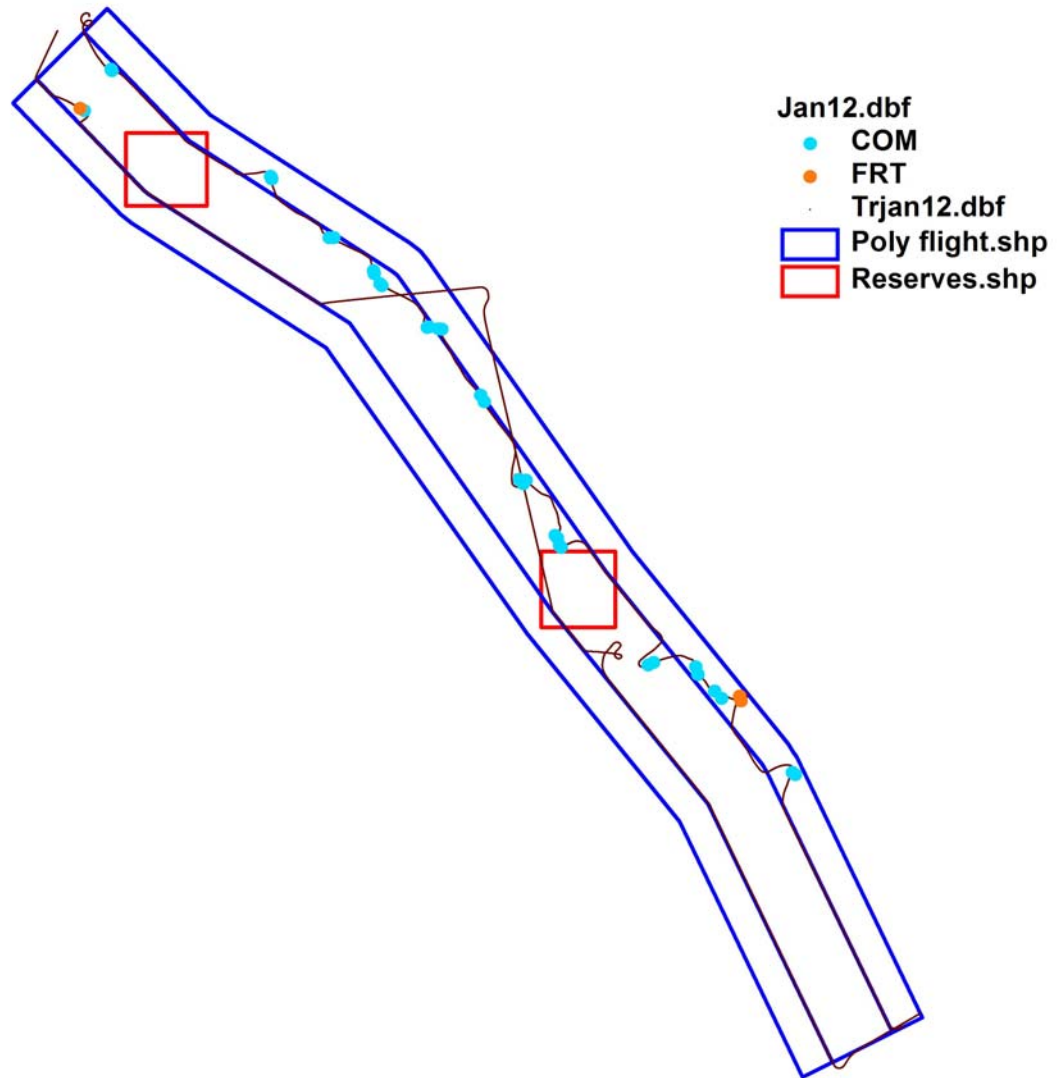
Day, Week, Time: Choose as needed; images are stored for 21 days only, so optimal time to obtain images is 7-10 days after a flight survey has been completed.

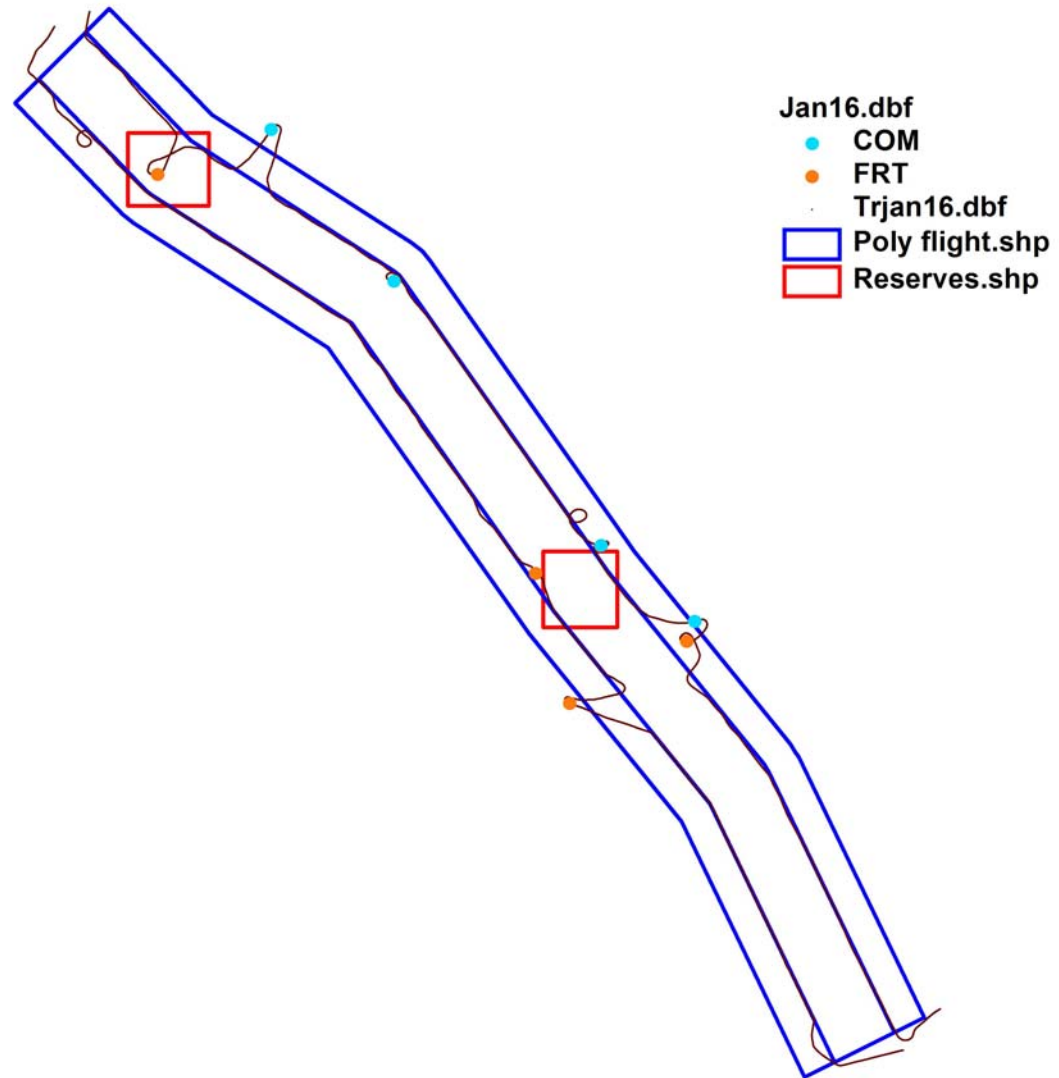
5. To save selected image, right click on image, 'Save as picture', save as .gif file to loop folder using filename of the image. The filename automatically denotes the sector, channel, year, day of year, and time.

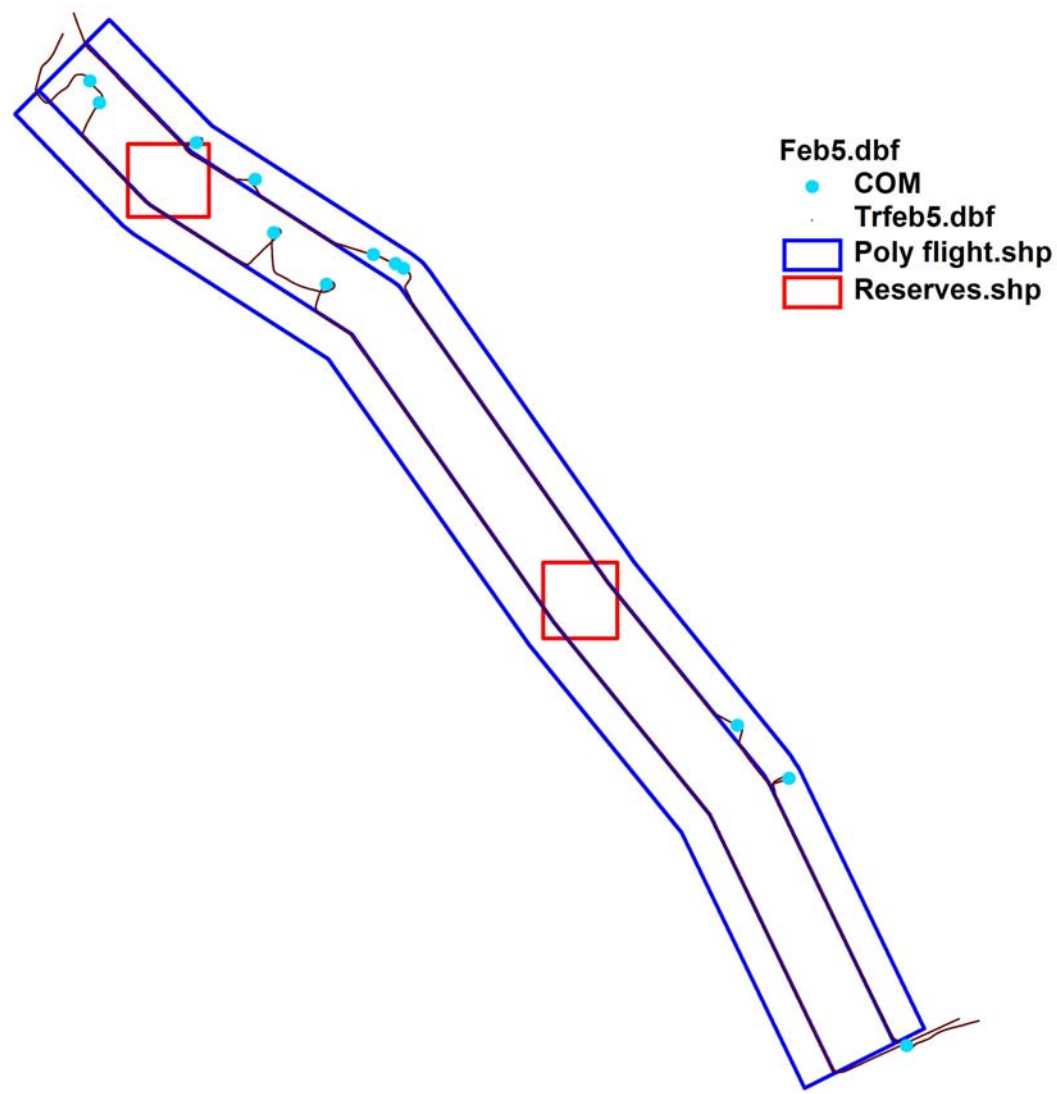
Appendix B: Daily Flight Maps

Appendix B1. Daily flight maps for Jan-Apr 2005 aerial surveys. Brown lines denote specific flight route. Vessel type codes: COM, commercial workboat; REC, recreational motorboat; FRT, freighter/cargo vessel; SAL, sailboat; OTH, other.

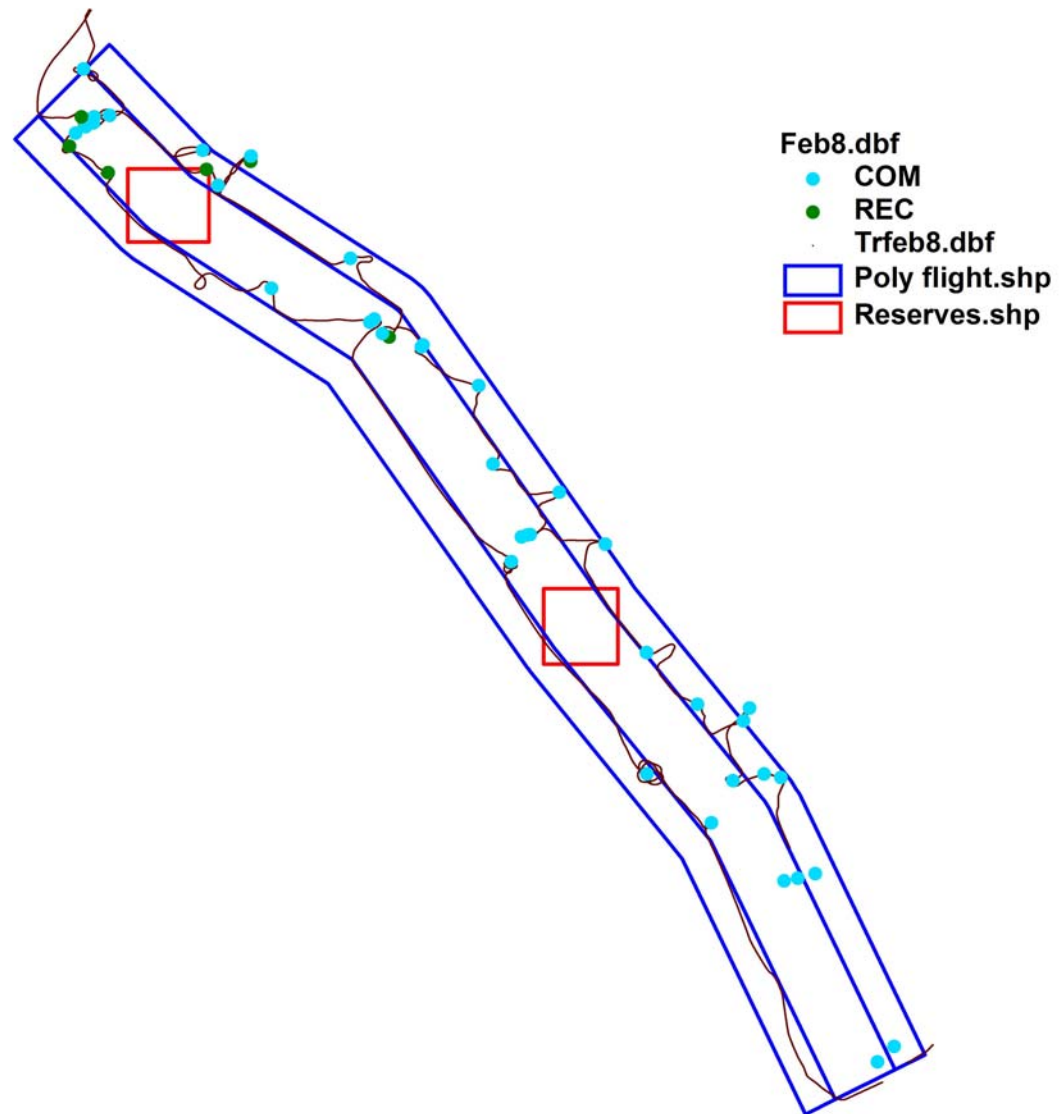


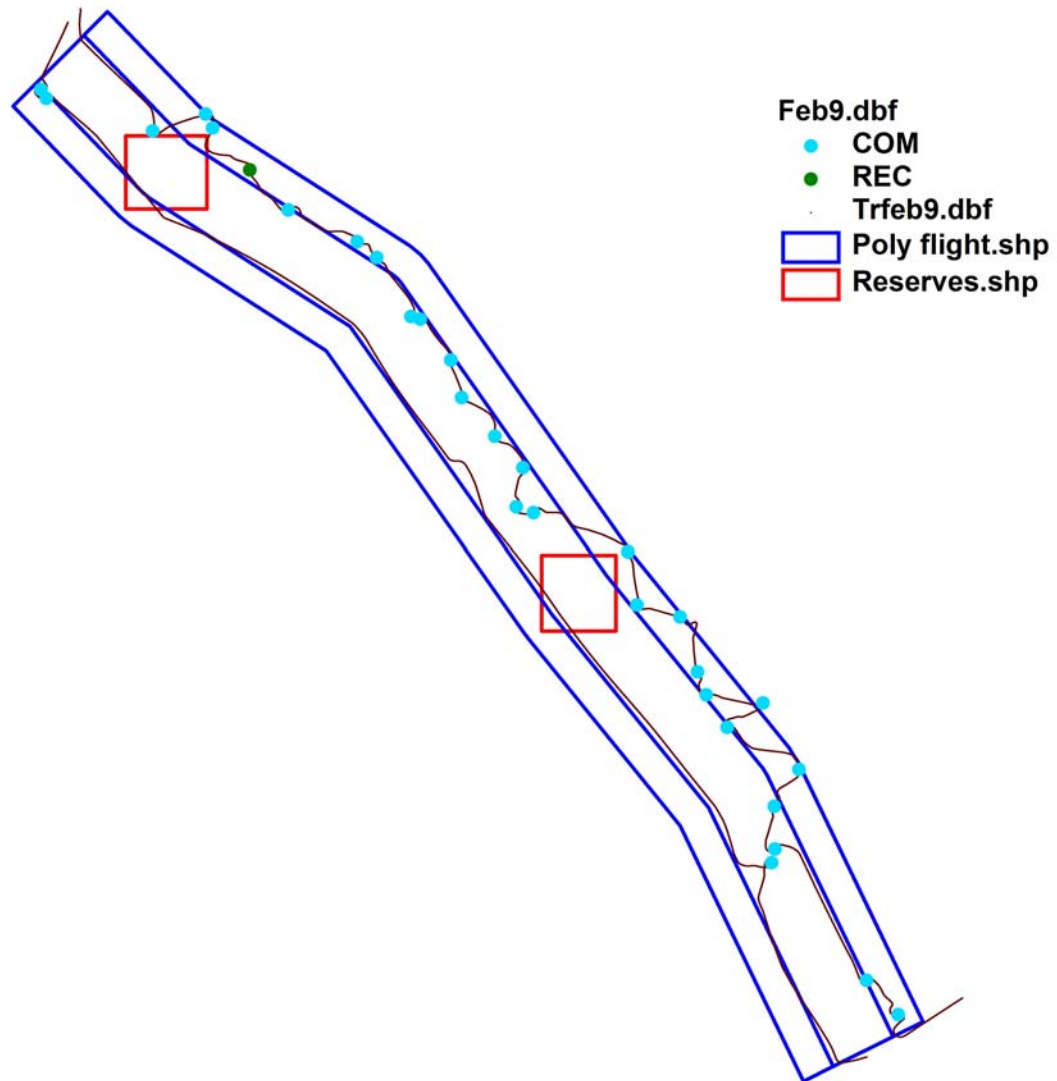


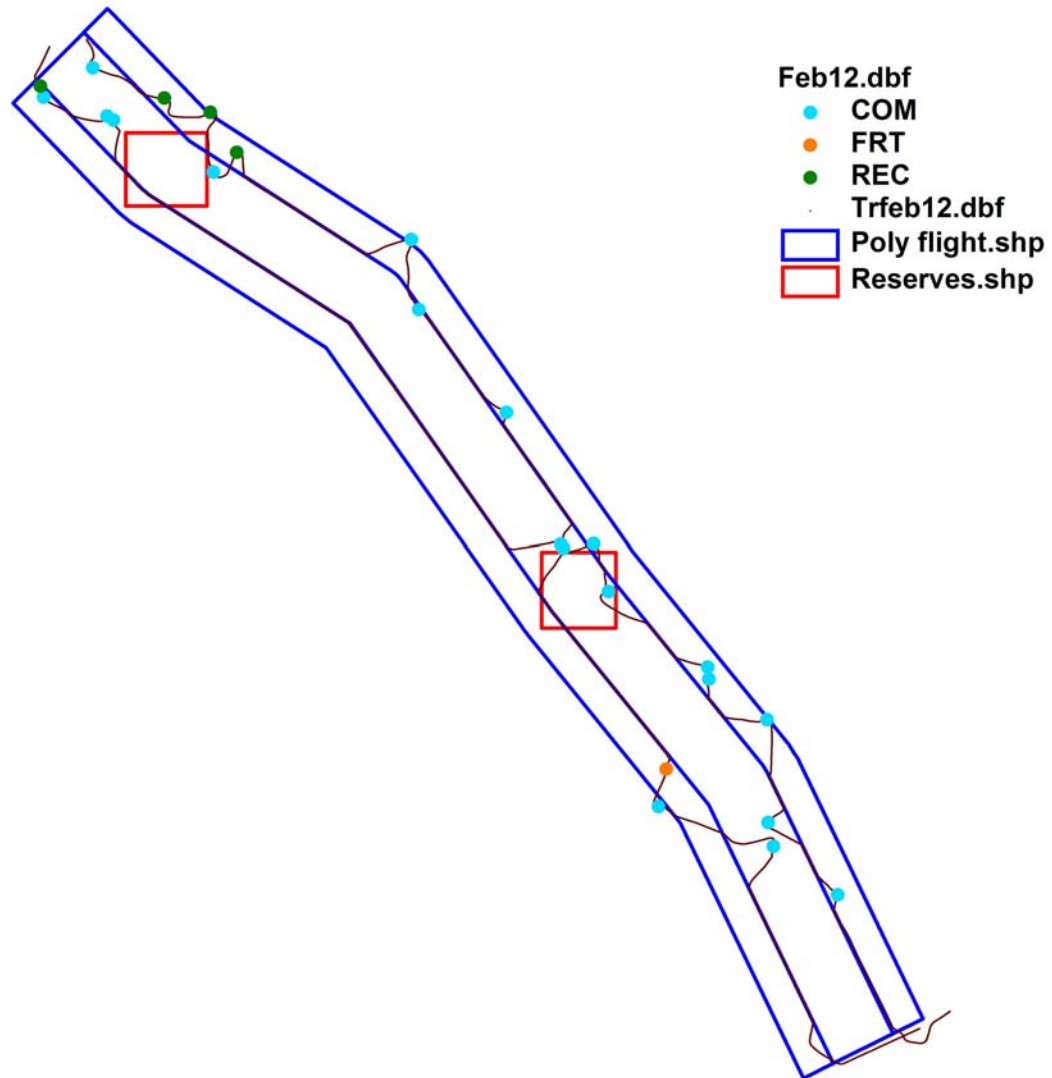


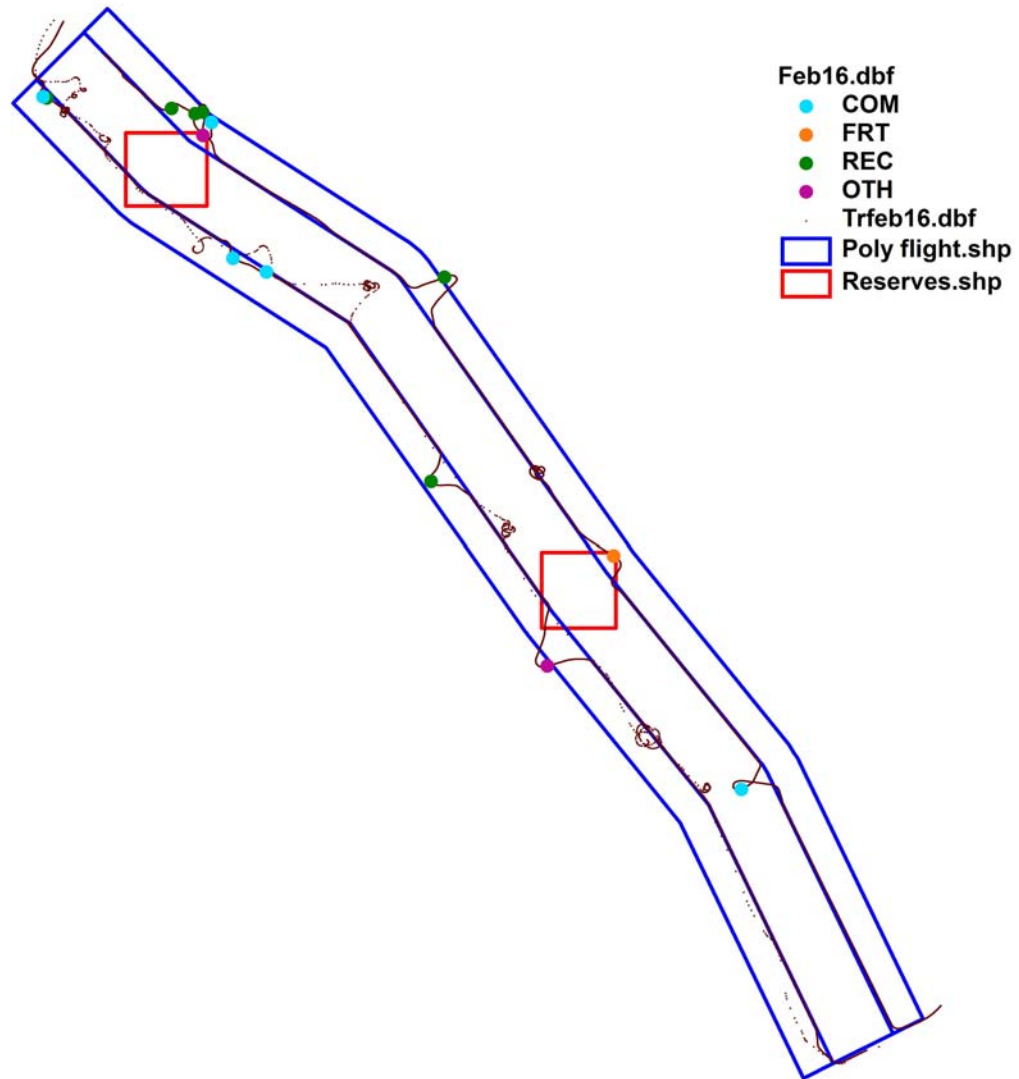


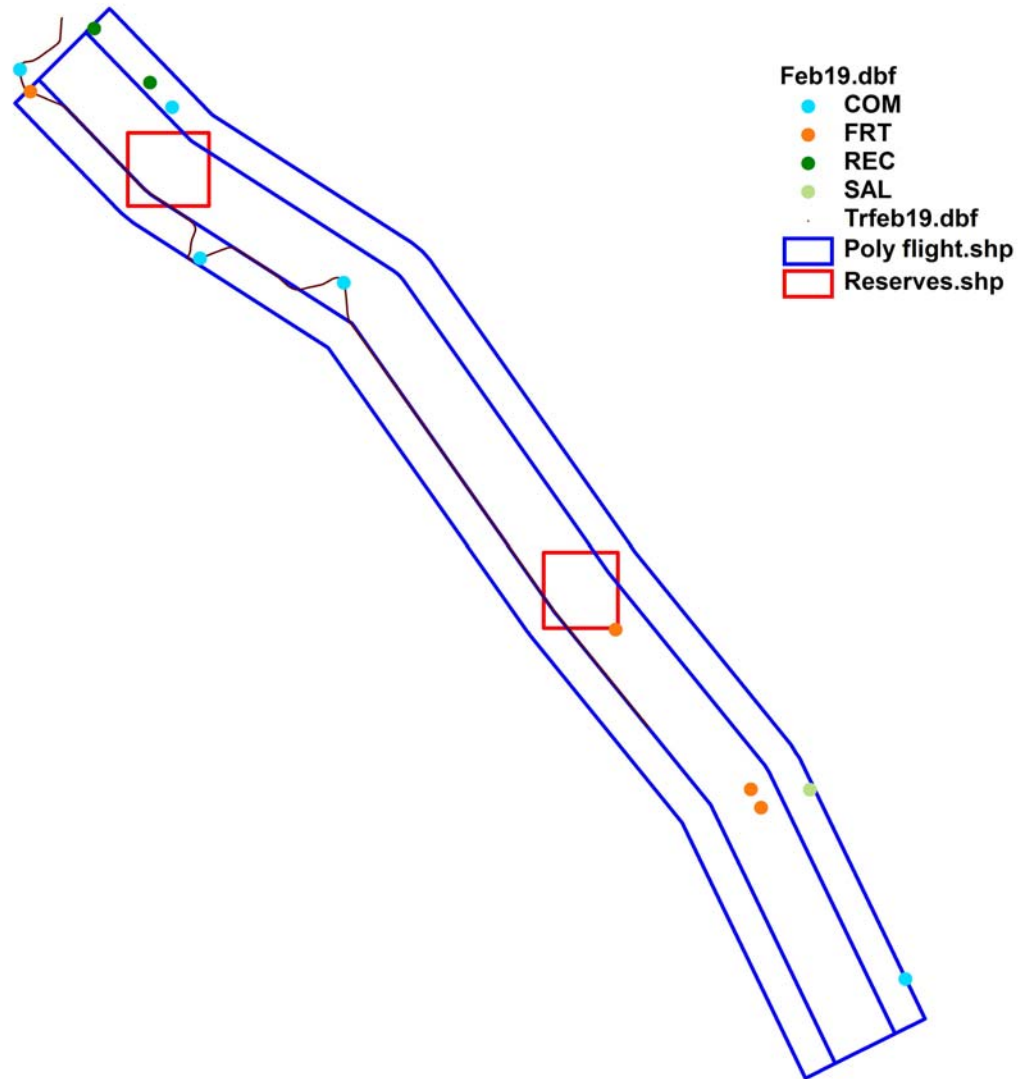
Feb5.dbf
● COM
Trfeb5.dbf
Poly flight.shp
Reserves.shp

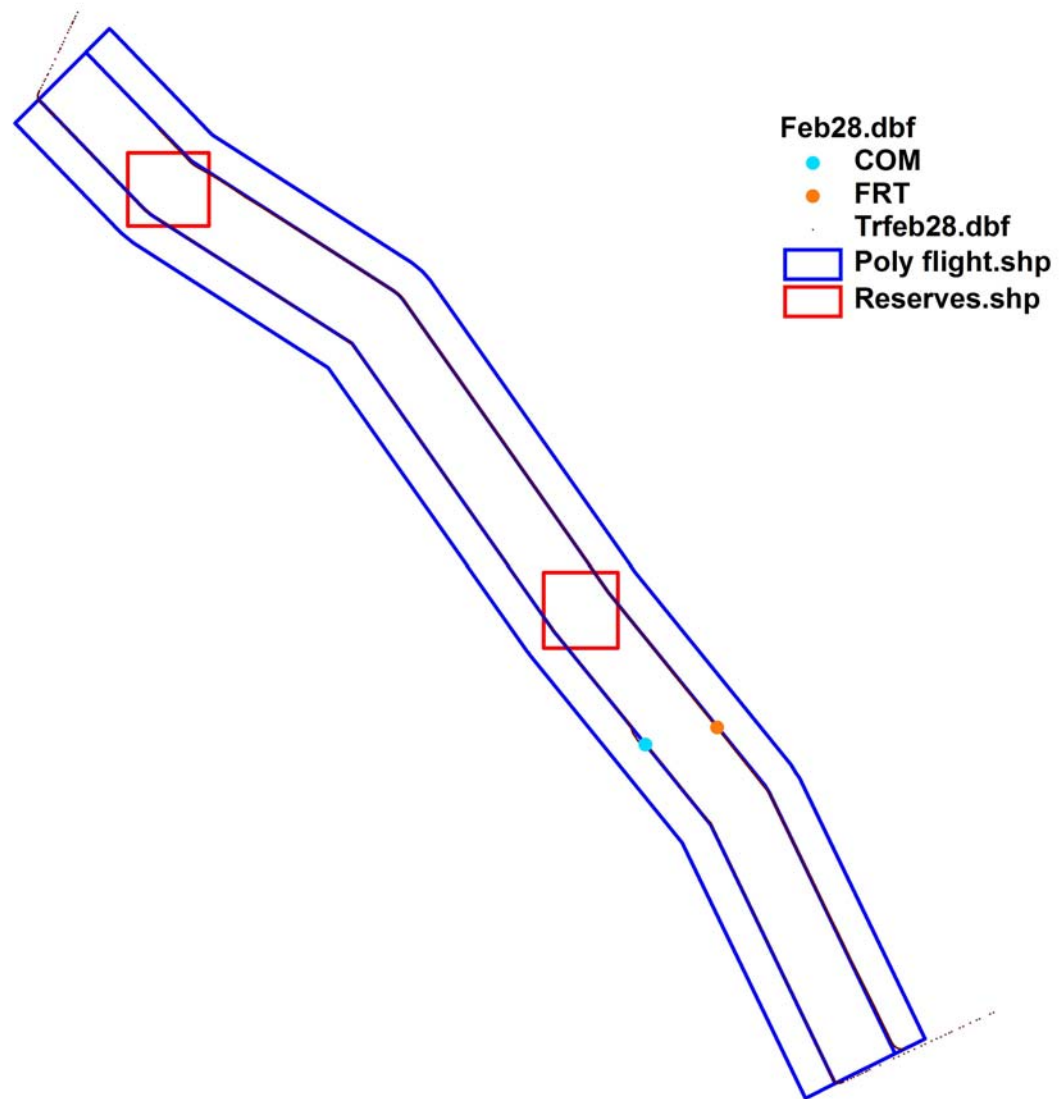


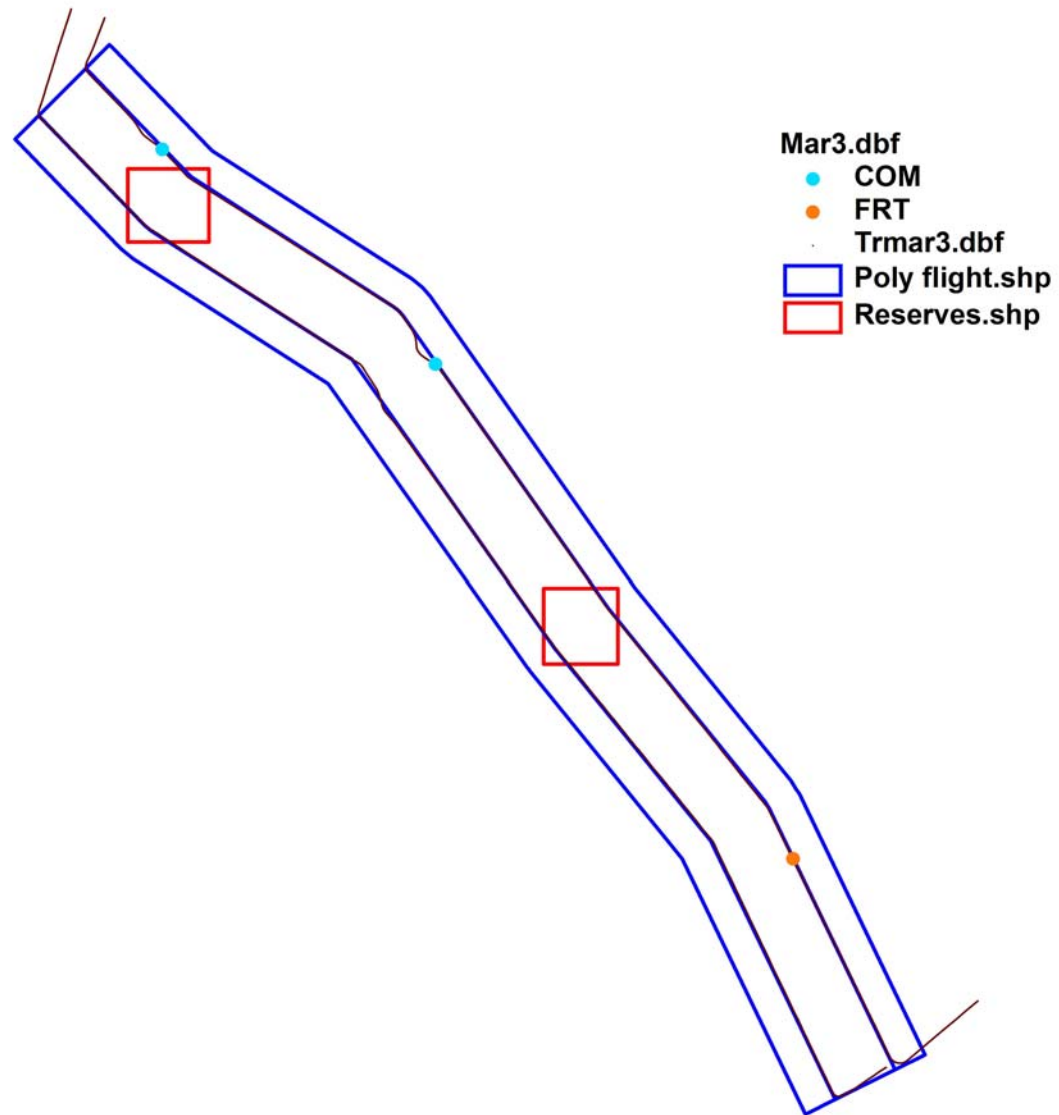


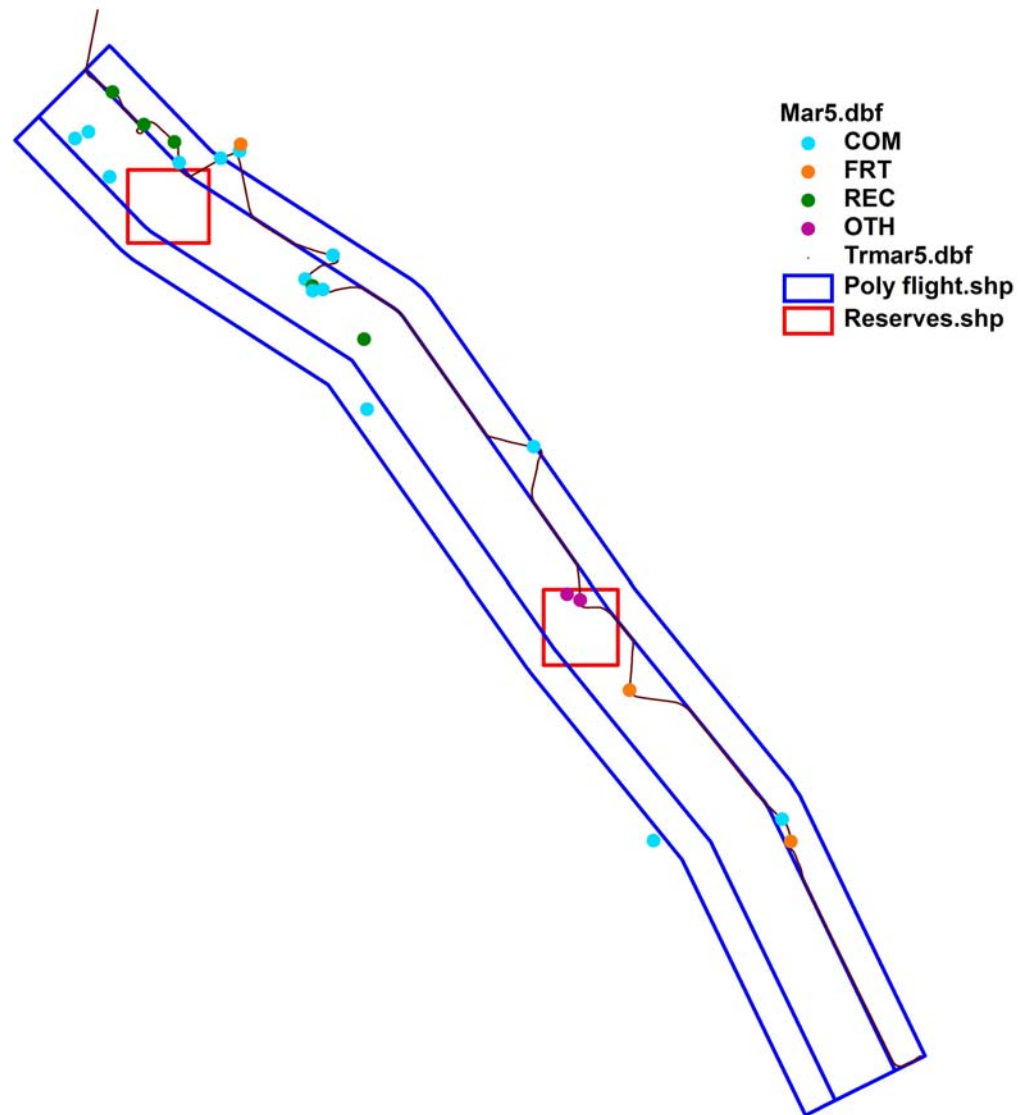


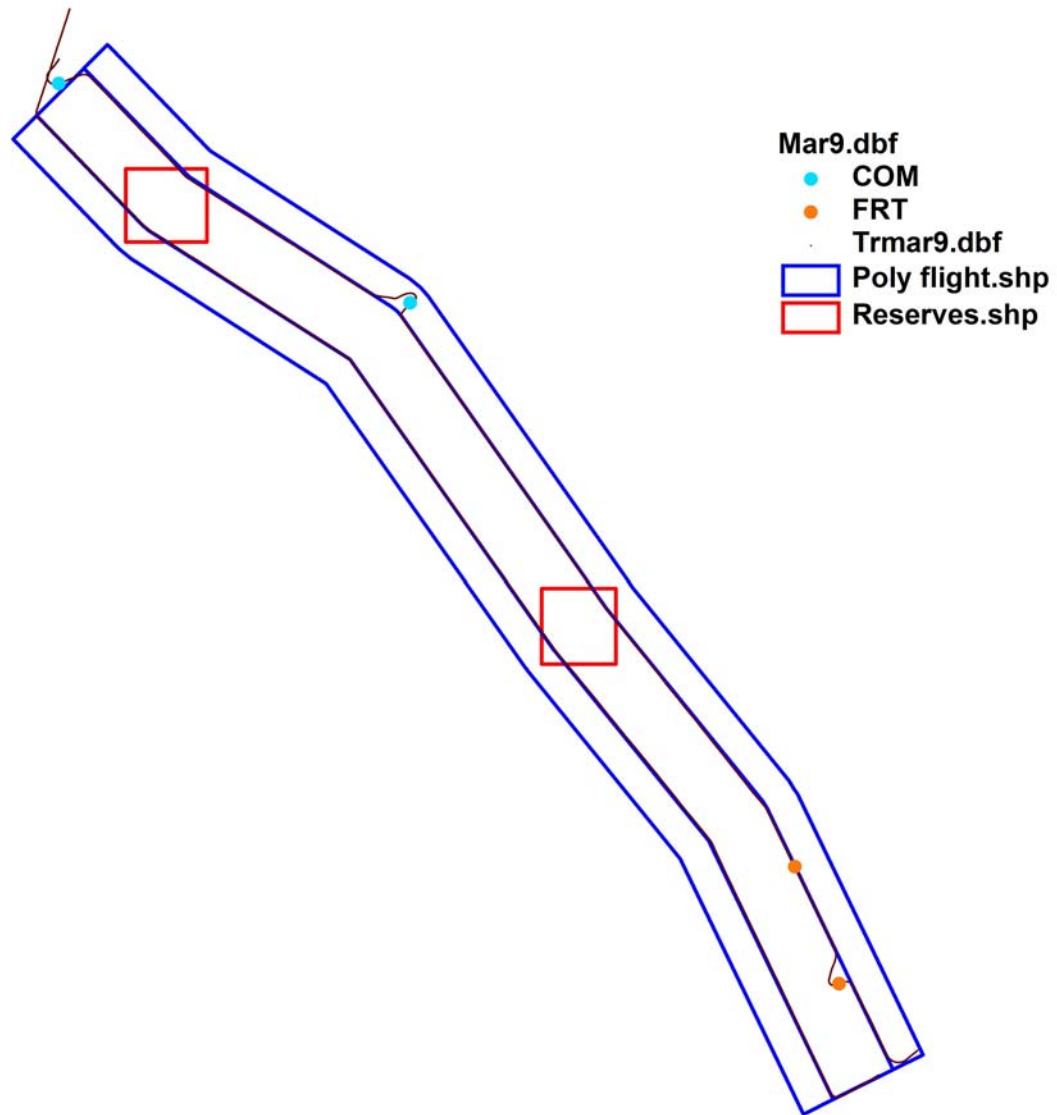


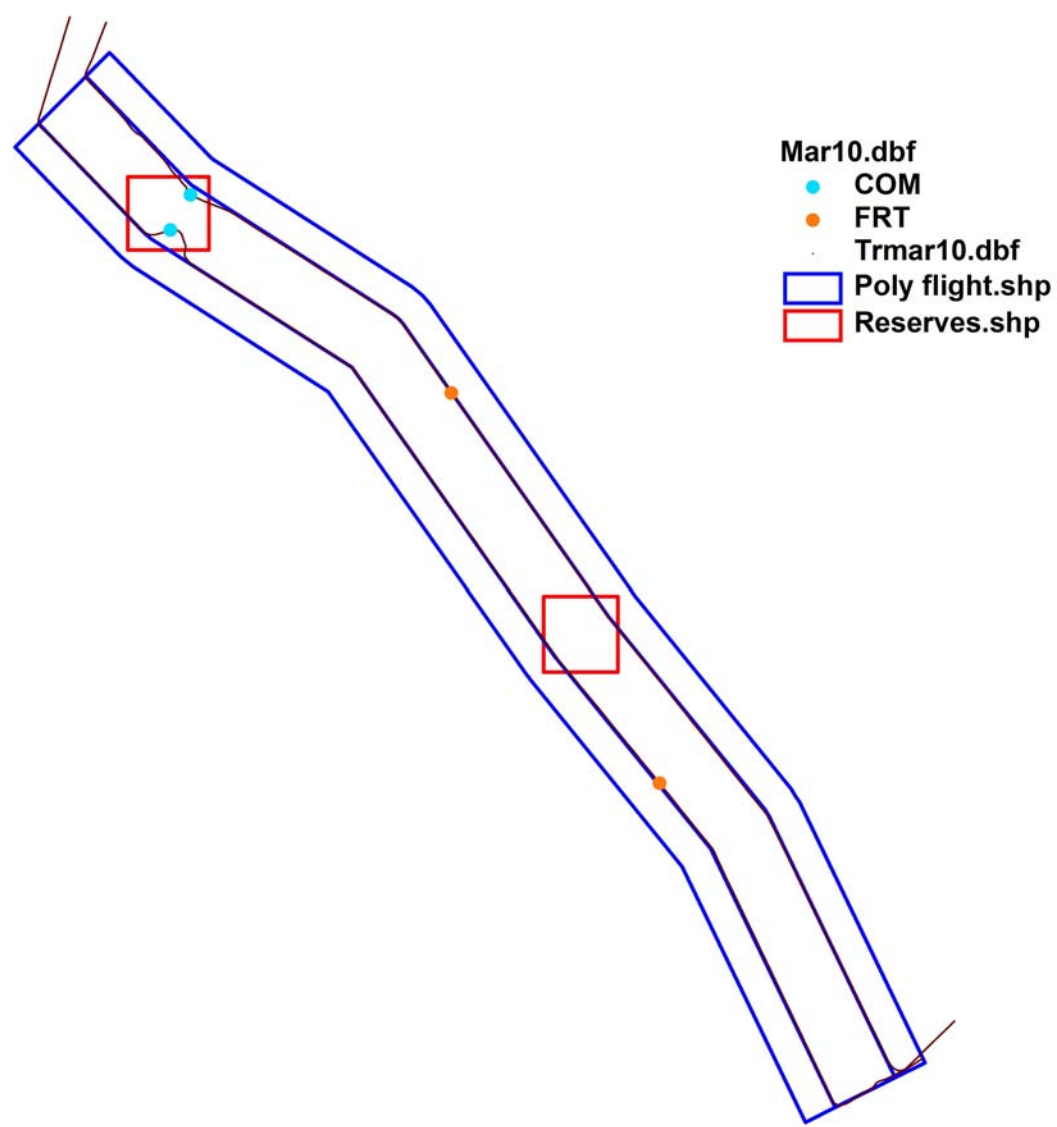


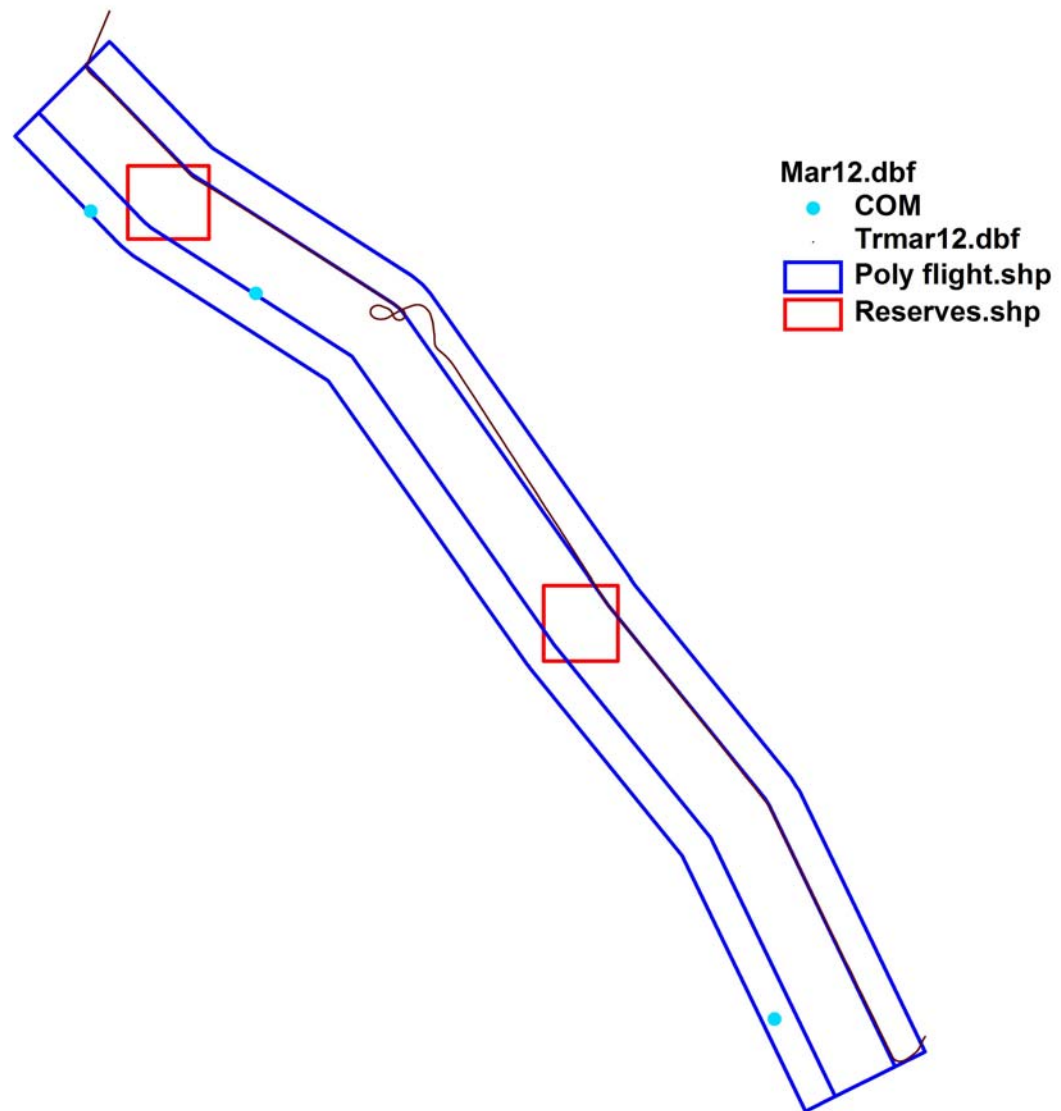


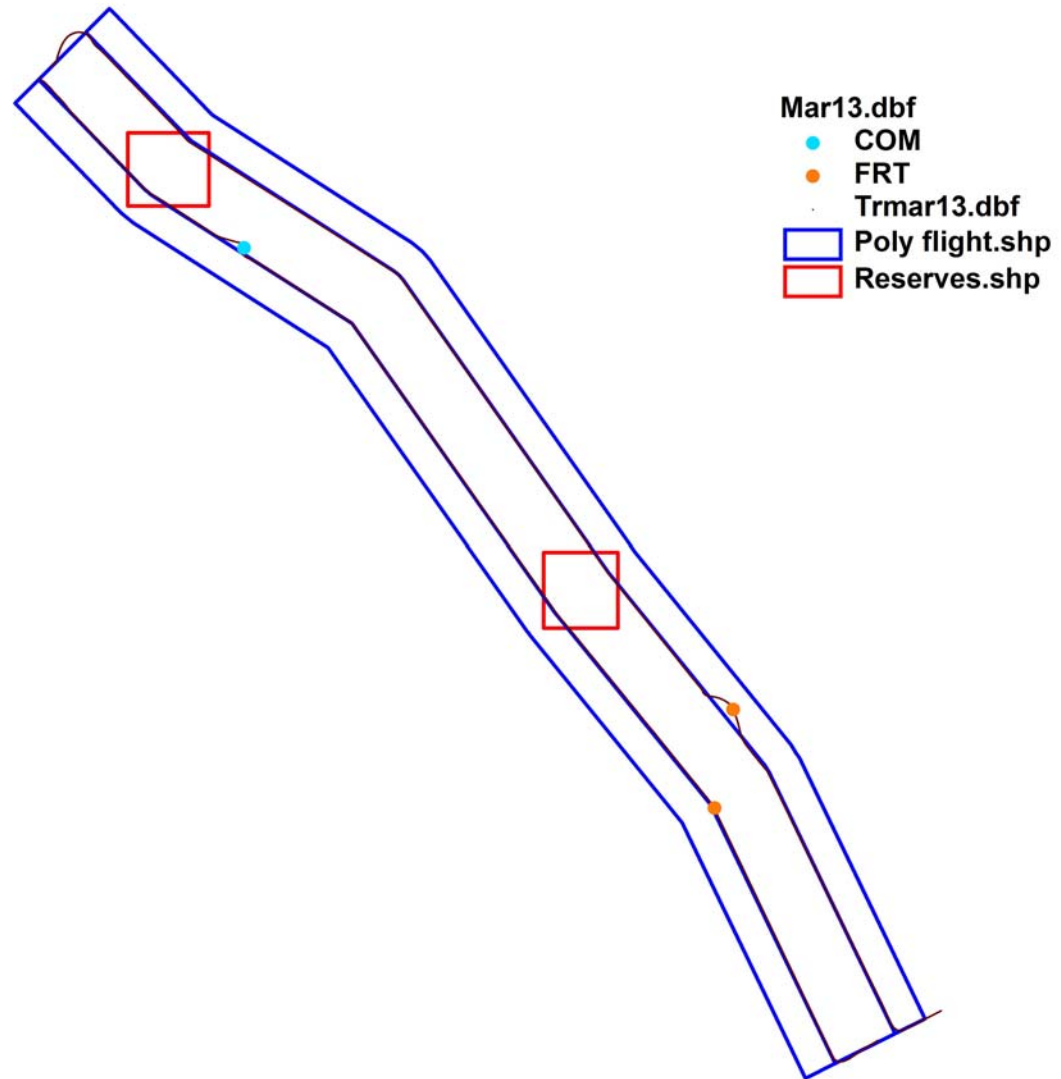


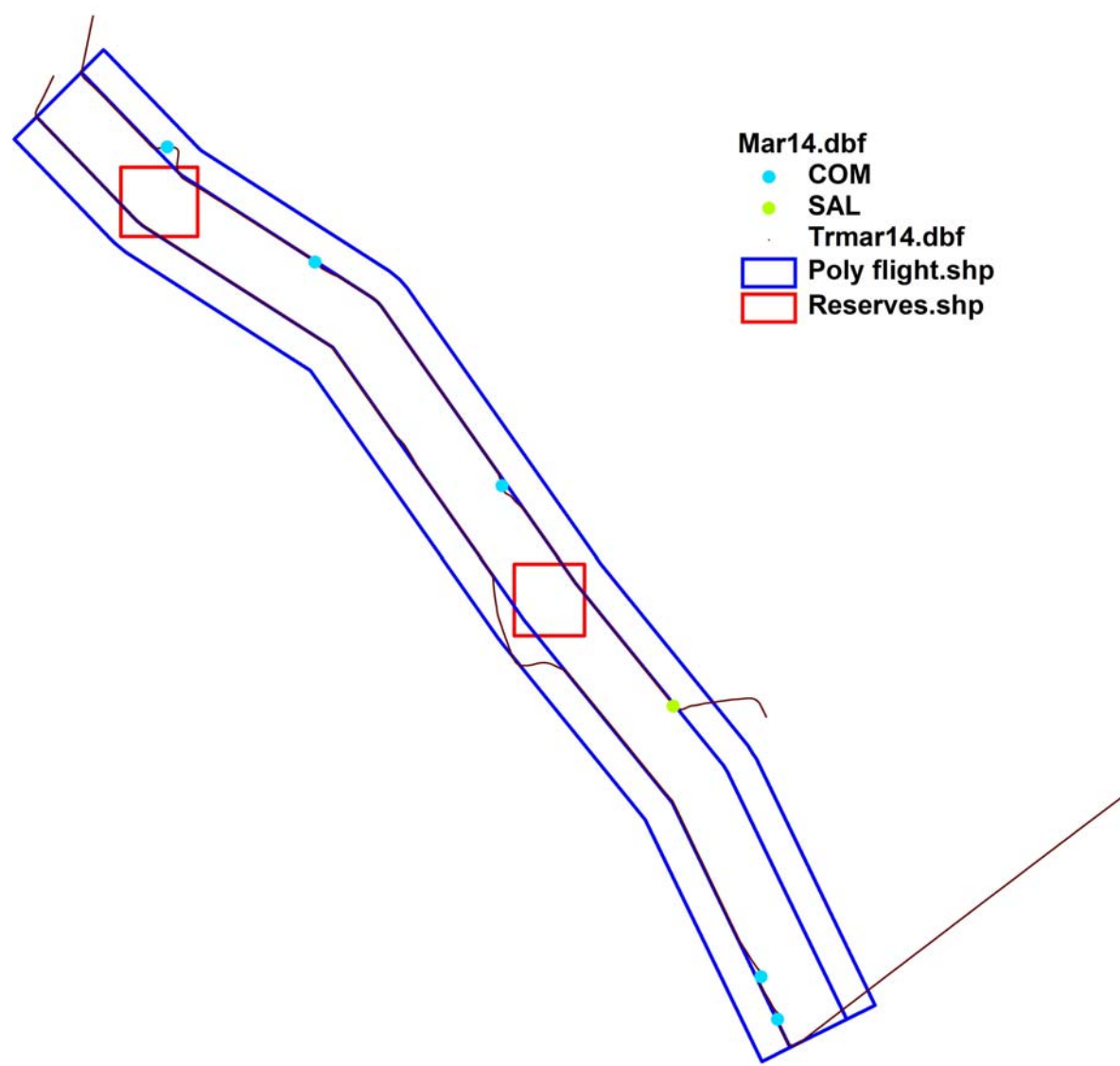




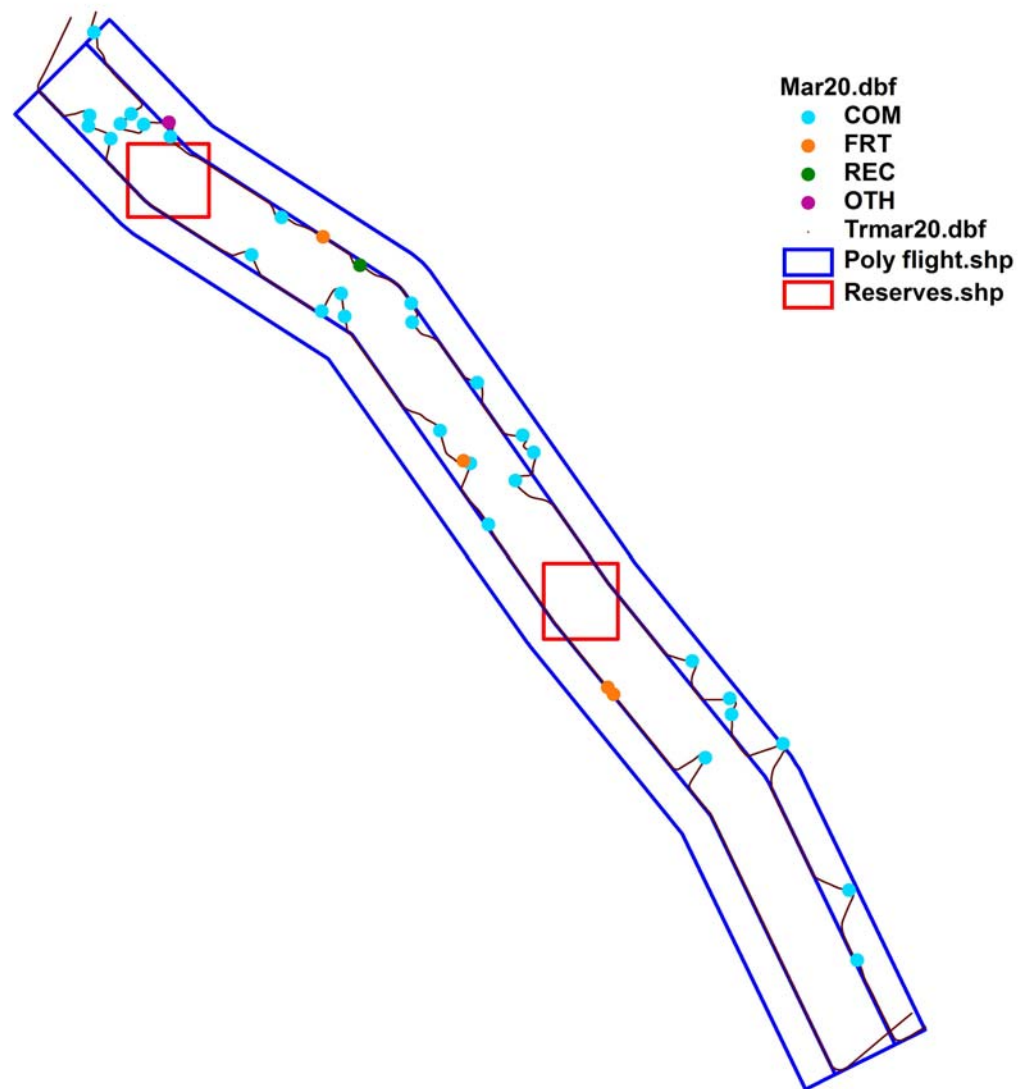


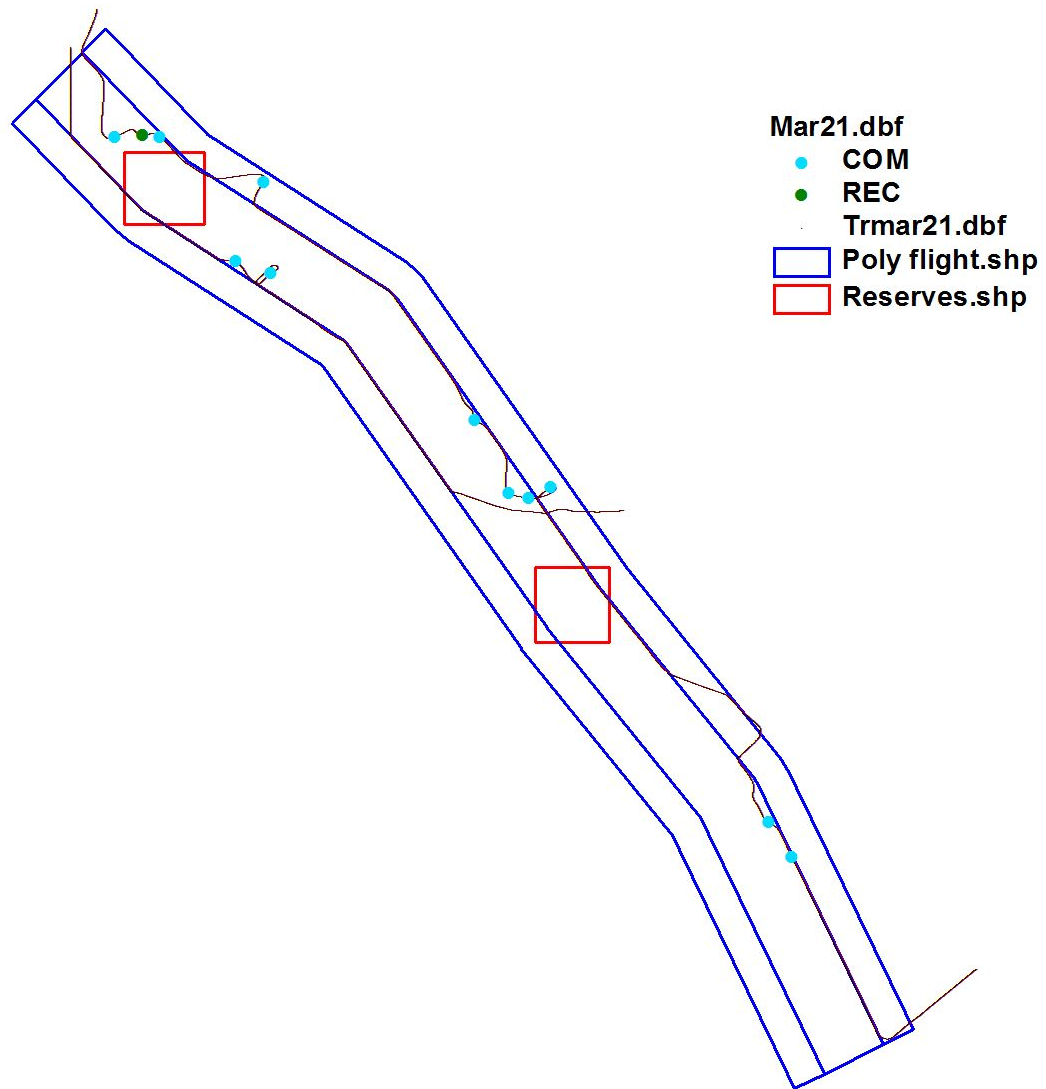






- Mar14.dbf
- COM
 - SAL
 - Trmar14.dbf
 - Poly flight.shp
 - Reserves.shp





Mar21.dbf

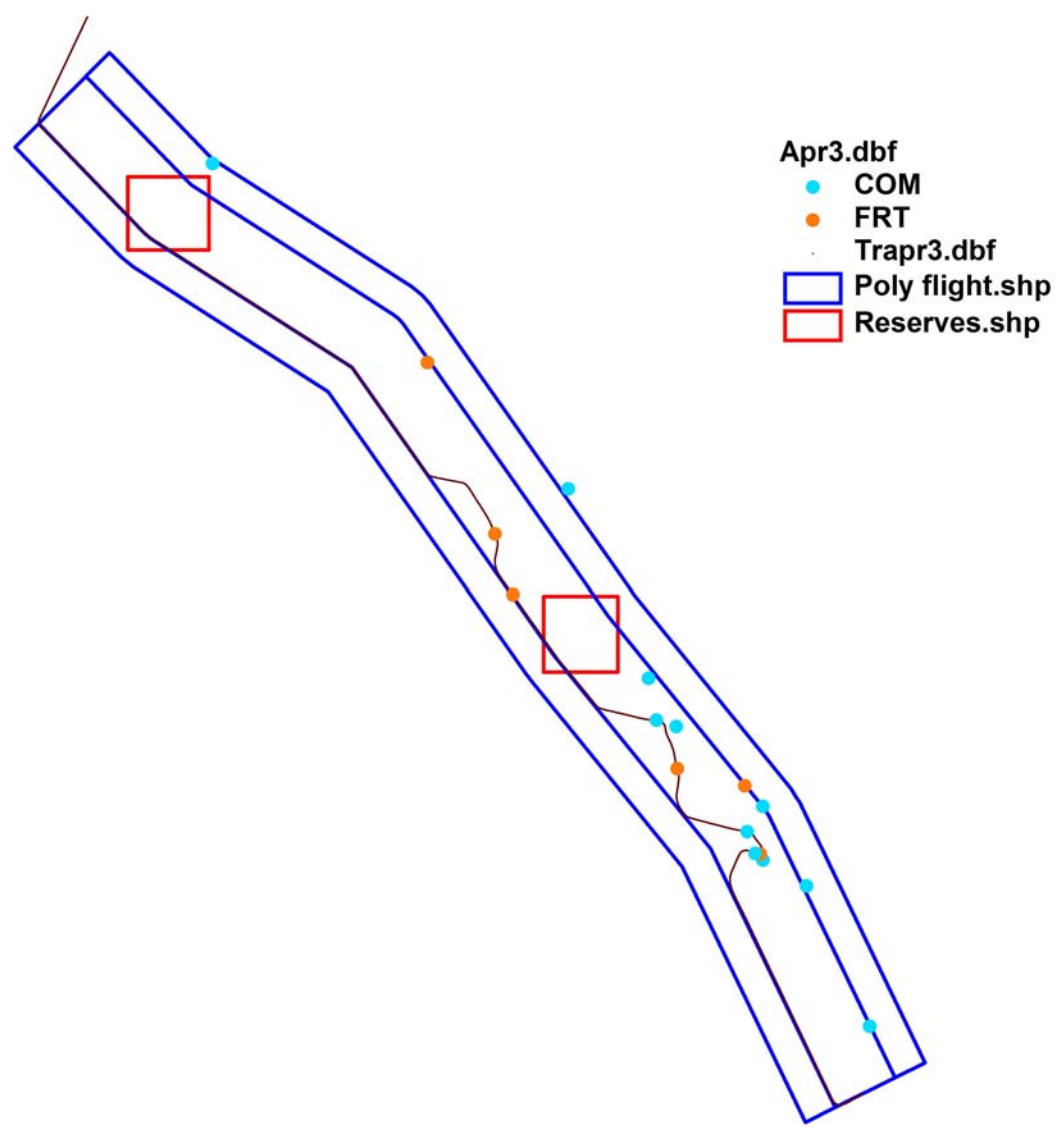
● COM

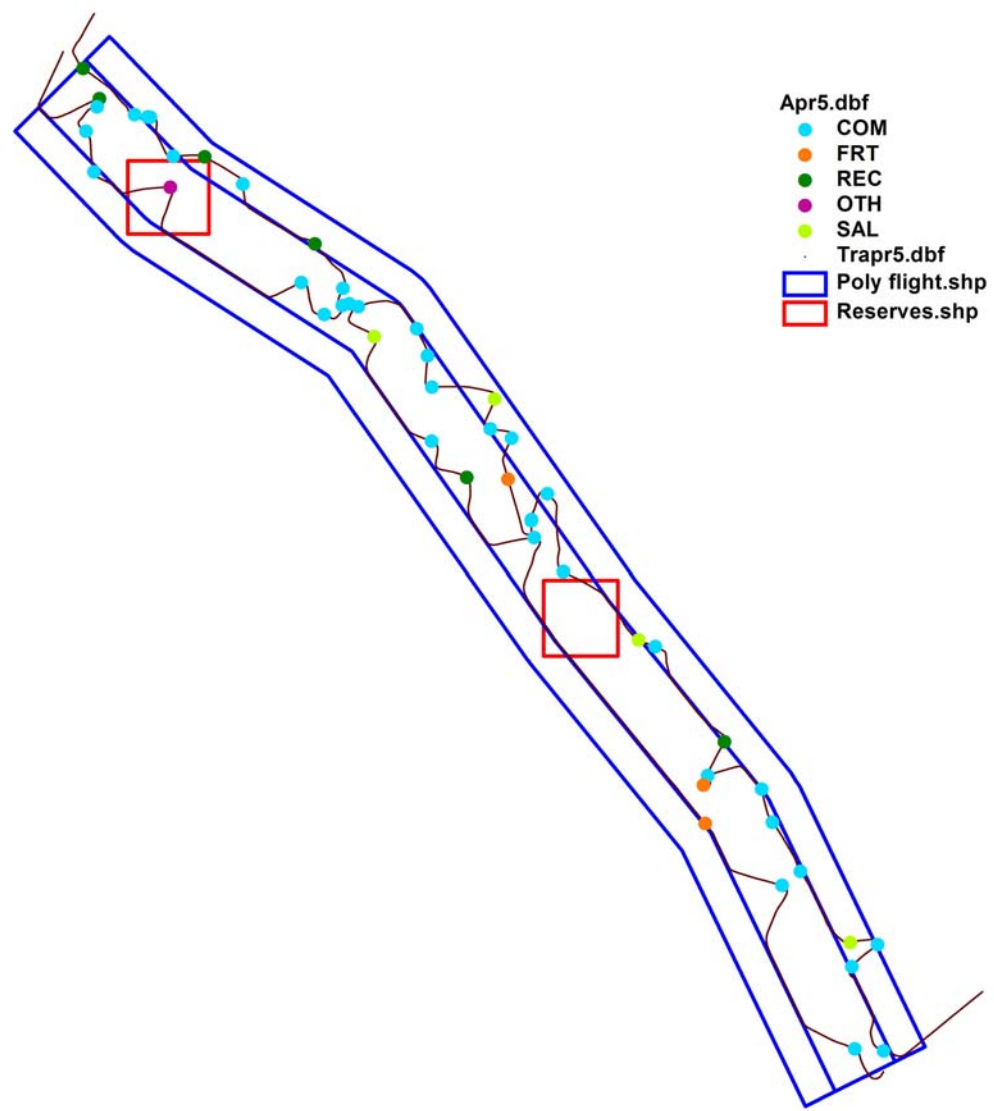
● REC

Trmar21.dbf

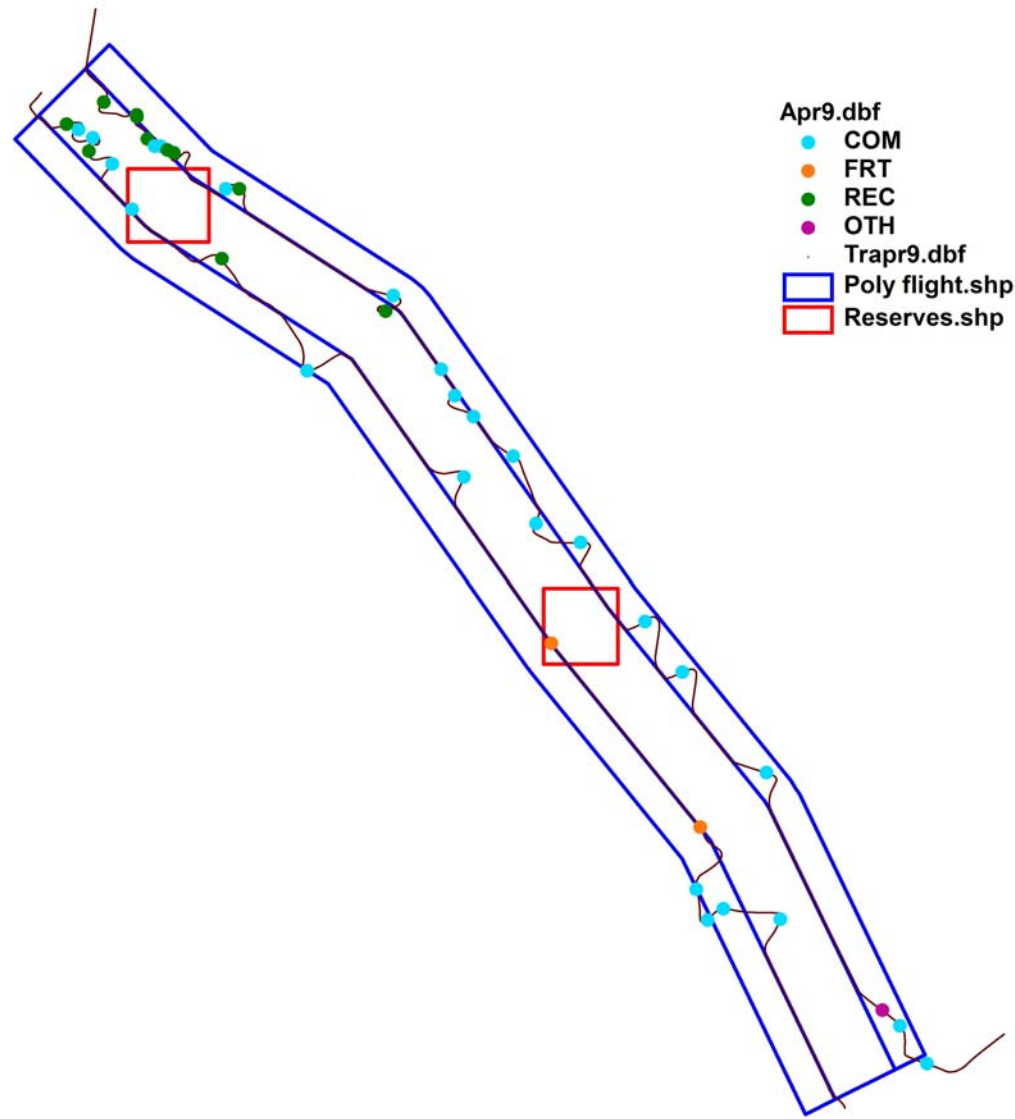
■ Poly flight.shp

■ Reserves.shp

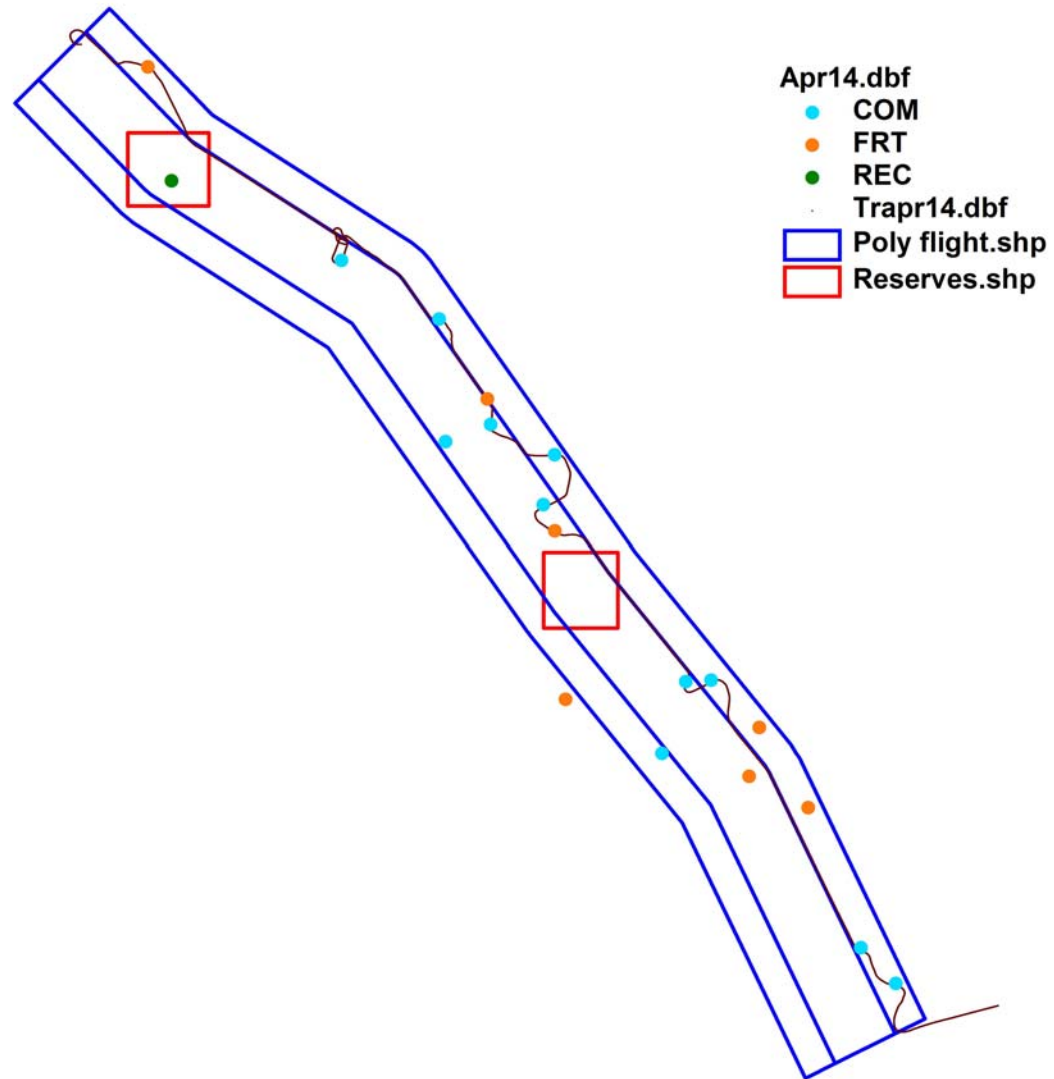


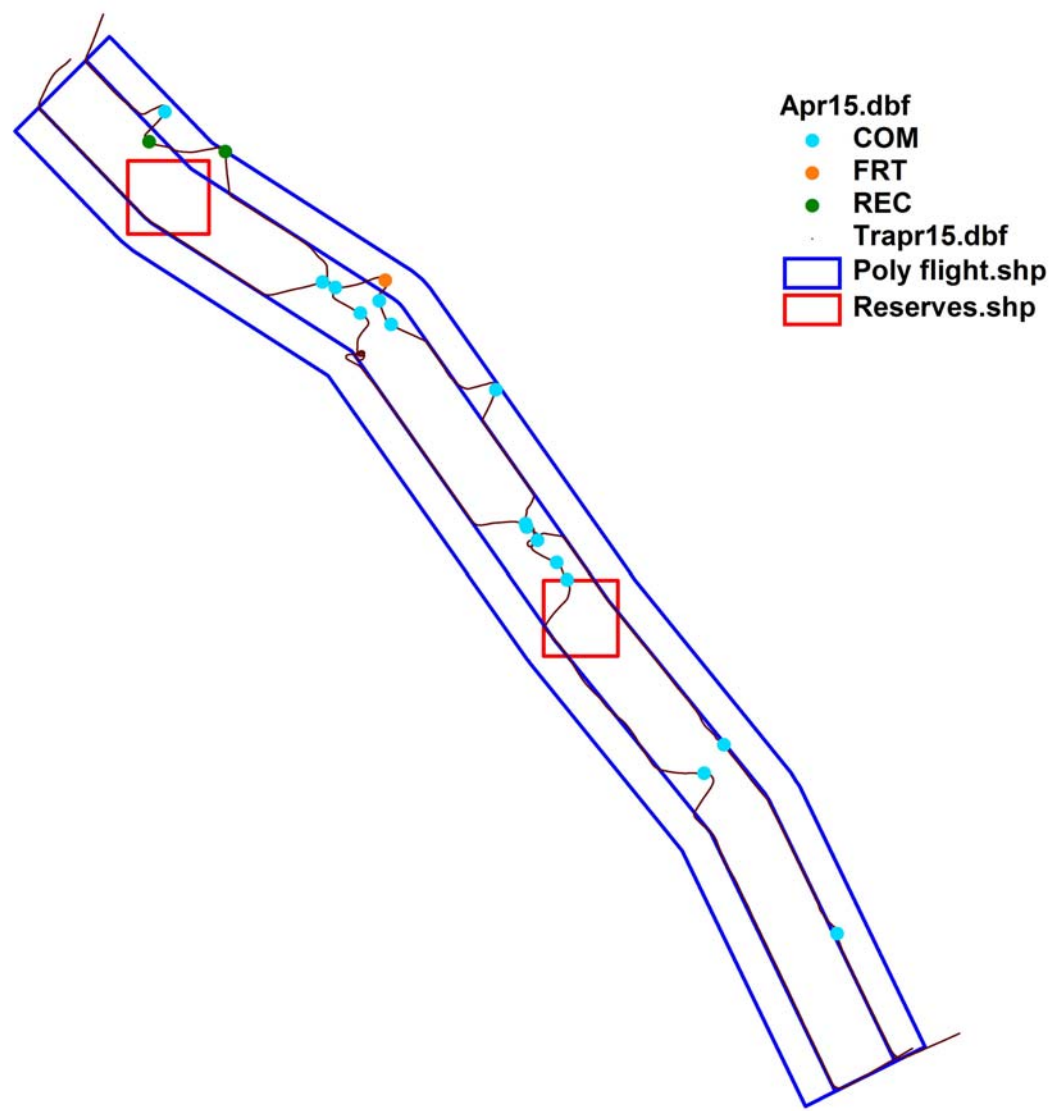


- Apr5.dbf
COM
FRT
REC
OTH
SAL
Trapr5.dbf
Poly flight.shp
Reserves.shp



- Apr9.dbf
- COM
 - FRT
 - REC
 - OTH
- Trapr9.dbf
- Poly flight.shp
 - Reserves.shp





Appendix B2. Daily flight maps for May-Sep 2005 aerial surveys. Brown lines denote specific flight route. Vessel type codes: COM, commercial workboat; REC, recreational motorboat; FRT, freighter/cargo vessel; SAL, sailboat; OTH, other.

